



Air Force

Systems Engineering Assessment Model



(AF SEAM)



Management Guide

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Executive Summary

The primary purpose of the Air Force Systems Engineering Assessment Model (AF SEAM) is to promote the application and use of standard Systems Engineering (SE) processes across the AF and to improve the performance of these processes through Continuous Process Improvement (CPI). This is achieved by providing both standard process definitions and an associated set of SE best practices tailored for use by United States Air Force programs and projects. These practices include the activities performed by technical professionals across the AF charged with the responsibilities of identifying, acquiring, testing and sustaining military weapon systems. Combined, these practices form the foundation for SE process discipline that leads to repeatable excellence in product life-cycle management and higher levels of customer satisfaction. The processes and associated practices address acquirer activities as well as activities conducted by the integrator or supplier and other organizations throughout the supply-chain. It is the acquirer's role to over-see the adequacy of the SE processes and ensure effective implementation of systems engineering. This includes those government processes that have been flowed down and are then delegated to the supplier. The final responsibility for the performance of the processes remains with the acquirer.

AF SEAM was developed to support both self-assessment and independent validation of systems engineering process implementation. Assessments based on this model should address the practices applicable to the area under examination for both those areas carried out primarily by the acquirer and the acquirer's SE processes intended to provide insight/oversight of others. Therefore, this model is intended to be tailored to meet the needs of the user.

Many of the best practices contained in AF SEAM were derived from various Software Engineering Institute (SEI) / Carnegie Mellon, Capability Maturity Model Integration® (CMMI®) products. Additionally, various international and industry standards, Department of Defense (DoD) publications and development team members' expert knowledge significantly contributed to the material contained in this model. It is essential to note that AF SEAM is a process assessment tool which is designed to assess the presence of needed SE processes as a "*leading indicator*" to subsequent delivery success. While the tool assesses the existence of SE process work products (i.e. CONOPS, plans, technical documents, etc) it does not assess the outcomes delivered to the customer. The model concentrates on "what" SE processes must be in place which, when properly executed, increase the likelihood customer needs will be satisfied. Therefore, AF SEAM must be used in conjunction with other more traditional tools to gain a full understanding of project / program status. Also, the model was designed to be flexible and simultaneously take full advantage of creative solutions and CPI by not bounding the user to prescribed implementation approaches ("how to") for achieving systems engineering best practices.

Finally, in its present state of development AF SEAM is not 100% correct and itself relies upon CPI. Recommended improvements or comments should be directed to your center's AF SEAM POC.

1. Introduction

The lack of robust systems engineering processes has been cited as one of the root causes of negative occurrences in acquisition and sustainment programs across the Department of Defense. Congressional and Department of Defense guidance emphasizes the need for sustained disciplined processes and process improvement including the measurement of process performance. The goal of this guidance is to influence the outcome of the acquisition process and delivery of the right capabilities to operational users, on schedule, and at predictable costs. At the same time, leaders in the Services continue to face aggressive performance, cost, and schedule baselines.

One way to meet these challenges is through the disciplined application of systems engineering, which provides the technical framework to enable sound decision making relative to trade studies among performance, supportability, cost, and schedule while considering risk. The successful implementation of proven, disciplined systems engineering processes results in a total capability solution that is:

- Robust to changing technical, manufacturing, and operating environments;
- Adaptive to the needs of the user;
- Balanced among the multiple requirements, design considerations, design constraints, and project schedules and budgets; and
- Operates smoothly in a complex system-of-systems environment when required.

Applying this approach demands renewed dedication to defining, implementing, measuring, and maintaining the systems engineering processes that are fundamental to successfully delivering a technically sound capability.

2. Purpose

The primary purpose of the Air Force Systems Engineering Assessment Model (AF SEAM) is to promote the application and use of standard Systems Engineering (SE) processes across the AF and to improve the performance of these processes through Continuous Process Improvement (CPI). AF SEAM was developed to support both self-assessment and independent validation of systems engineering process implementation. Assessments based on this model should address the practices applicable to the area under examination for both those areas carried out primarily by the acquirer and the acquirer's SE processes intended to provide insight/oversight of others. AF SEAM is lean by design and is therefore targeted to meet the users need when a more complex/detailed approach (e.g. CMMI) is not required.

This model defines a standard view of systems engineering processes within the AF and defines expected SE process outcomes. The descriptive guidance under the title "Other Considerations" for each practice provides suggestions for implementation that can be used for training and continuous process improvement. While this model identifies practices that should be implemented it does not prescribe specific implementation

approaches. This provides a basis for acquisition process discipline, while balancing the need for flexibility, and tailoring to specific AF user needs.

3. AF SEAM Model Content

AF SEAM defines ten AF standard SE process areas, lists associated goals under each process area and provides associated specific and generic practices. Many of the best practices contained in AF SEAM were derived from various Software Engineering Institute (SEI) / Carnegie Mellon, Capability Maturity Model Integration® (CMMI®) products. Additionally, various international and industry standards, Department of Defense publications and development team members' expert knowledge significantly contributed to the material contained in this model. It is essential to note that AF SEAM is a process assessment tool which is designed to assess the presence of needed SE processes as a *“leading indicator”* to subsequent delivery success. While the tool assesses the existence of SE process work products (i.e. CONOPS, plans, technical documents, etc) it does not assess the outcomes delivered to the customer. The model concentrates on “what” SE processes must be in place which, when properly executed, increase the likelihood customer needs will be satisfied. This is due to the fact that the quality of a System or Product is highly influenced by the quality of the process used to develop and maintain it.

AF SEAM was designed to facilitate user tailoring. Tailoring is accomplished in one of two ways. First, specific practices which do not apply to the area under examination may be coded not applicable (N/A), and therefore would not be assessed. Care should be taken to ensure a practice is not omitted which upon closer examination may not be customarily considered for inclusion, but should be included to promote overall mission success. Generic practices may not be omitted, although in the highly unlikely event that an entire process area is omitted, generic practices would not apply to that area. Secondly, users may add to AF SEAM to cover areas not specifically included in the base model. Where tailoring is used, content may be added to the AF SEAM, however, original content may not be deleted.

3.1. AF SEAM Core Document Format

AF SEAM is built around ten **Process Areas** which are at the highest level of the model. These process areas are supported by **Goals**. Goals are amplified by **Practices**. Practices fall into two categories: **Specific** and **Generic**. Following is a detailed description of each.

3.1.1. Process Areas (PAs)

Process areas are individually described in terms that define the overarching purpose and concepts associated with the process area. A process area is further defined by a grouping of related goals and practices which implemented collectively satisfy the stated purpose of the process area. It should also be noted that multiple individual processes are required to successfully achieve practices and goals which comprise an overall process area.

AF SEAM is comprised of ten process areas which are presented in alphabetical order with their associated acronym below:

CM: Configuration Management
DA: Decision Analysis
D: Design
M: Manufacturing
PP: Project Planning
R: Requirements
RM: Risk Management
TFS: Transition, Fielding, & Sustainment
TMC: Technical Management & Control
V: Verification & Validation

3.1.2. Specific Goals (SG)

A specific goal describes the unique characteristics that must be present to satisfy the goal. A specific goal is a required model component and is helpful in the grouping of associated practices and is used in assessments to improve clarity of understanding.

3.1.3. Specific Practices (SP)

The title associated with each specific practice defines the desired activity. Below the practice title is an area titled “Description”. The description area contains amplification and clarification of the practice. In most cases the description defines the minimal activity required to successfully meet the practice.

3.1.4. Generic Practices

Generic practices are called *generic* because the same practice applies to all ten process areas individually. A generic practice is the description of an activity which is considered important to facilitate successful achievement of the specific practices and process area goals associated with an overarching process area.

Process areas and their associated number of goals and practices are summarized in the table below:

Process Area	Goals	Specific Practices	Generic Practices	Total Practices
Configuration Mgmt	3	8	7	16
Decision Analysis	1	5	7	12
Design	3	14	7	21
Manufacturing	4	12	7	19
Project Planning	3	15	7	22
Requirements	4	13	7	21
Risk Mgmt	3	7	7	14
Trans, Fielding, & Sus	4	15	7	22
Tech Mgmt & Control	4	15	7	18
Verification & Validation	5	16	7	23
Total	34	120	70	190

3.1.5. Typical Work Products

The typical work products section lists various outputs which are expected to be an outcome of the process / processes which are executed to successfully achieve the practice. These examples are called “typical work products” because while they are often the outcomes produced, other work products that are just as effective may also be produced but are not listed.

3.1.6. Reference Material

Reference material has been provided for practices under the heading “Reference Material”. The items listed are provided as an aid and are not intended to represent all potentially applicable reference materials. In addition to the tailoring of practices previously described under paragraph 2.0, user tailoring which includes the addition of applicable lower level reference material to this section is encouraged. Users should not rely upon the information given in this model alone and are therefore are encouraged to become familiar with referenced documents. Most reference material has been hyperlinked to common access sites that do not require a Government Common Access card (CAC). To access the links, simply place the cursor over the reference and perform the <Control><Click> sequence.

3.1.7. Other Considerations

Other considerations are detailed descriptions that provide guidance for interpreting and implementing a practice. These considerations suggest “best practices” within a practice area. In addition to the tailoring of practices and reference materials

previously described, user tailoring which includes the addition of lessons learned is encouraged.

3.2. Systems Engineering References

Many systems engineering process standards and models exist that describe best practices in accomplishing systems engineering. Process areas, goals and associated practices described in this model were derived from a number of sources, including those listed below. Additionally, proven practices have also been gleaned from experienced professionals who assisted with the model's development. Examples of the references used include the following:

- ISO/IEC 15288, Systems Engineering-System Life Cycle Processes
- ANSI/EIA 632, Processes for Engineering a System
- IEEE 1220, Application and Management of the Systems Engineering Process
- EIA 731, Systems Engineering Capability Model
- CMMI, Capability Maturity Model Integration
- Defense Acquisition Guidebook, Chapter 4
- AFI 63-1201, Life Cycle Systems Engineering
- IEEE/EIA 12207, Software Life Cycle Processes
- Air Force Weapon System Software Management Guidebook

Process areas and associated definitions were developed to best meet AF SE needs and are in alignment with current DoD and AF guidance as summarized in the table below:

AF SEAM	Defense Acquisition Guide	AFI 63-1201
Requirements	Reqs Analysis, Reqs Mgmt, Stakeholder Reqs Definition	Reqt Dev & Mgmt, & Architecture
Design	Architectural Design, Integration & Interface Mgmt	Design & Interface Mgmt
Verification & Validation	Verification & Validation	Test & Evaluation, Verification & Validation
Manufacturing	Implementation	Design
Transition, Fielding, & Sustainment	Transition	Design
Project Planning	Technical Planning	Planning
Configuration Management	CM, Data Mgmt, Technical Data Mgmt	Configuration Mgmt, Data Mgmt
Risk Management	Risk Mgmt	Integrated Risk Management
Technical Mgmt & Control (PMC)	Technical Assessment	Technical Reviews & Measurements
Decision Analysis	Decision Analysis	Decision Analysis

3.3. Terminology

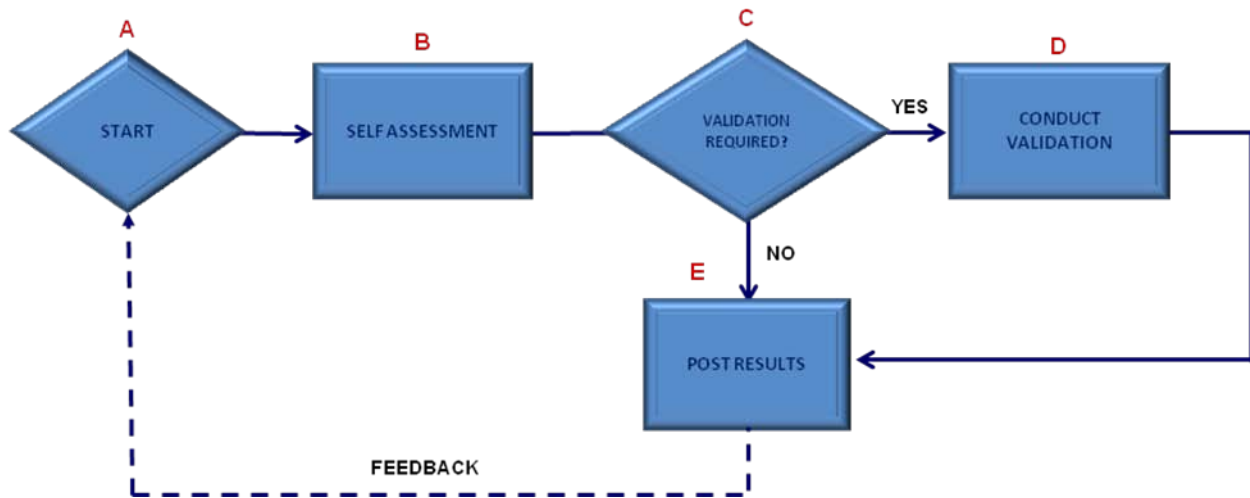
In general, this model uses the terminology used within the CMMI framework. References to CMMI and AF SEAM terminology should be understood in both the acquisition and the process improvement contexts.

- The term “project” denotes a managed set of interrelated resources that delivers one or more products to a customer or end-user. In this document, a “project” could refer to an entire acquisition program or, perhaps, a major subset of an acquisition program. The scope of the term is tailored to the specific acquisition.
- The term “organization” is typically used to denote an administrative structure in which people collectively manage one or more projects.

- The term “acquirer” refers to the organization responsible for acquisition of the product or component. This is typically the Government and might include both the project or program office and sponsoring office. It can also apply recursively down the supply-chain (i.e., the integrator fulfills an acquirer role when working with sub-tiers in the supply-chain)
- The term “integrator” refers to the organization performing the work of product integration (e.g., the prime contractor).
- The term “supplier” refers to all organizations in the supply-chain including the integrator and other organizations responsible for providing a subassembly, component or part of the product.
- The term “work product” is any artifact produced by a process.
- The term “product” denotes a tangible output or service that is a result of a process and that is intended for delivery to a customer or end user. A product is a work product that is delivered to the customer.
- The term “establishing” includes changing documenting and providing a description.
- The term “maintaining” includes changing documentation as necessary.
- The term “system” is not used in the CMMI framework or in the AF SEAM process areas except in the general sense (e.g., systems engineering).
- The term “systems engineering” includes software engineering.
- The term “stakeholder” refers to a person, group, or organization that affects or can be affected by an organization’s actions.
- Readers should decide how these terms apply to their environment.

4. AF SEAM Assessment Process

The below diagram describes the overall AF SEAM assessment process. The following paragraphs summarize what occurs during each phase of the process.



4.1. Leadership Engagement - A

The process is started by leadership who direct that a project/program office conduct a self-assessment (A). Leadership initiates a self-assessment based upon a multitude of factors including: an event, schedule, Earned Value Management (EVM), other feedback, type of program, etc. At the outset, leadership may also direct that the self-assessment be followed by a validation assessment, or may choose to wait until the results of the self-assessment are known.

4.2. Transitioning From Start (A) To Self-Assessment (B)

Following leadership direction to start the process, the Center Engineering home office, or others directed by leadership who are knowledgeable of the AF SEAM assessment process, engages with the project/program selected for study. If the people working in the subject project/program office have previously conducted AF SEAM self-assessments and all participants are familiar with the assessment process, roles and responsibilities, recording and reporting requirements, then no further action on the part of the Engineering home office is required. However, if the individuals working within the area of study are unfamiliar with AF SEAM, then the Engineering home office initiates actions to provide project/program leadership with the *AF SEAM Leadership Training*. Members of the Engineering home office will assist with the identification of specific roles and responsibilities, planning for the overall assessment effort, and providing *AF SEAM Self-Assessment Training* to all self assessors needing the training.

4.3. Self Assessment Phase - B

During the self-assessment phase, members of the selected project/program office will perform a self-assessment. Before initiating the self-assessment, AF SEAM will be

tailored to meet the specific needs of that particular project/program. Tailoring will be accomplished as described in paragraph 3, *AF SEAM Model Content*. The self-assessment is accomplished using the AF SEAM Assessment Tool or other locally approved recording mechanism. Every practice not specifically omitted, and practices added during tailoring, will be individually assessed and graded. As the self assessors complete the self-assessment, Engineering home office personnel will be available to answer questions and provide assistance as required. At the conclusion of the self-assessment, results are reported to the project/program leadership, and when requested also to those who initiated the process if they are different. (See paragraph 6, *Results Reporting*).

4.4. Validation Determination - C

If not already directed to do so, at this time leadership will determine if an independent validation is required. If a validation assessment is not desired then the results are posted to file and the process terminates. However, if leadership determines that a validation assessment is required, the Engineering home offices (or others designated as responsible) are notified.

4.5. Transitioning From Validation Determination (C) To Validation Assessment (D)

Following completion of the self-assessment phase, if leadership has directed that a validation assessment be accomplished, actions are initiated to prepare for an independent validation. Upon receipt of this direction the Center Engineering home office, or others directed by leadership who are knowledgeable of the AF SEAM assessment process, will begin/continue the assessment planning process. Planning will encompass all actions necessary to accomplish a validation assessment. This traditionally includes: identifying and securing team members, training validation assessment team members, arranging all necessary logistics support, planning interviews, coordinating with leadership to establish a schedule, securing data from the self assessment phase, and defining team member roles and responsibilities. It is customary that validation teams be comprised of members who were not previously involved in the self-assessment, and whenever possible members will not be from the same organization.

4.6. Validation Assessment Phase - D

The validation assessment phase begins with a team meeting during which the team leader reviews the information prepared in paragraph 4.5., *Transitioning From Validation Determination (C) To Validation Assessment (D)*. Assessment team members should leave this meeting with a clear understanding of the effort before them, their individual role and responsibilities, the resources available, and the schedule. Assessment team members begin their individual work by reviewing all available material for their area of assignment including the self-assessment data. The information derived during the self-assessment serves as a starting point from which independent assessors determine correctness of model usage during the self-assessment phase. Validation assessors also use this data in combination with their interviews to confirm correct interpretation of *practices* by the self assessors. Independent assessors provide accurate feedback and recommendations to project/program personnel. Although the details of how this is

accomplished are determined at the Center level (or Wing level in the absence of a Center), it is intended that the validation assessment be a collaborative effort between the project personnel and the validation assessment team. AF SEAM is not intended to be a compliance check or an audit of the project/program. Instead it is intended to facilitate a mutual understanding of ways to obtain process excellence as described in AF SEAM, identify gaps in *specific* and *generic practice* attainment with a mindset toward continuous process improvement. Areas that are identified as needing improvement should attract increased attention and support from leadership who aid in closing the process performance gaps. At the conclusion of the validation assessment, actionable recommendations are provided by the validation assessment team to project/program members and leadership. It is suggested that project/program personnel then prioritize and address the gaps based on their business and process improvement goals and objectives.

4.7. Posting Results – E

Information is compiled as directed by local policy and procedures. Results must be tabulated and formatted to support standard reporting as defined in paragraph 6, *Results Reporting*. Additionally, results should be maintained in a manner that facilitates feedback and thereby supports continuous process improvement. Finally, results must be readily accessible by project/program personnel to enable self-improvement.

4.8. Feedback

The purpose of feedback is primarily three-fold. First and foremost AF SEAM is a process improvement tool that is intended to be employed by process owners, those working within these processes, and those directly overseeing them. For this tool to be employed successfully, it relies upon the candor of process participants in an environment of leadership support to improve the process. Therefore, the primary use of AF SEAM is by process participants for the purpose of aiding all to better improve the process and its associated products/outcomes. The second primary use of AF SEAM is the capture of process improvement ideas and lessons learned in an area that will be immediately visible to those needing this information. This is accomplished by updating the area under each practice titled “Other Considerations”. Center Engineering home offices may update this area for the AF SEAM tool being used at their Center as part of the tailoring process. Centers are also encouraged to share this information with the office responsible for AF SEAM configuration management and control, which after reviewing the input with other stakeholders across the AF, may elect to include this additional information in future model iterations. The third primary use of AF SEAM feedback is to share results with those who are best positioned to facilitate improvement above the project/program level (see paragraph 6, *Results Reporting*). Leadership assistance may include: provision of additional resources, policy change, or mutual acceptance of risk.

5. Assessment Methodology

5.1. Self-Assessment Methodology

The Air Force SEAM relies on a combination of various assessment techniques. Participants perform self-assessments using information and data readily available to them. Self-assessors may use the tool provided in the AF SEAM Tool Suite or one that is made available through the Center organization to which they are assigned. Although there is flexibility in recording tool usage, results reporting is standardized. Each practice (*specific* and *generic*) are graded as either satisfied (1 or colored green) or not satisfied (0 and colored red).

5.2. Validation-Assessment Methodology

Validation assessment teams are usually comprised of individuals from the parent organization's Engineering home office and others selected by this office to augment the team. Assessors rely upon the information developed during the self-assessment phase. Validation assessors use this information, personal interviews, and independent research to determine if a practice is being met. Those directly responsible for the processes under consideration are a critical resource to the validation assessors. As with self assessors, validation assessors may use the tool provided in the AF SEAM Tool Suite or one that is made available through the Center organization to which they are assigned. Although there is flexibility in recording tool usage, results reporting is standardized. Each practice (*specific* and *generic*) are graded as either satisfied (1 or colored green) or not satisfied (0 and colored red).

6. Results Reporting

6.1. Overview

Results reporting takes into consideration the needs of those to whom the information is being reported. The goal is to provide various levels of organizational leadership with:

- the information needed, and
- in the level of detail required,

to best support continued process improvement. For this reason, Program Managers (PMs) and members of the program/project office using AF SEAM need to see the results down to the individual practice level. PMs need this level of understanding regarding the various SE processes operating within their individual projects/programs to know where to focus their attention down to the Action Officer level. Center and MAJCOM leadership need the information in a format that best enables them to view entire portfolios at the process level. This is to facilitate Center and MAJCOM level analysis in a broader sense. This broader process view allows Center and MAJCOM leaders to focus on continually improving processes across entire Centers/MAJCOM's while simultaneously allowing individual PMs to focus on the details of their individual areas of responsibility. Therefore, while the underlying data is the same, the outputs are tailored to meet the needs of those using it.

Reporting is accomplished for *specific* and *generic* practices separately. This is to provide appropriate visibility into the separate practices, and to avoid confusion by the reviewer due to different underlying scoring algorithms. Each practice is graded as either satisfied or not satisfied. These results are then aggregated to yield a color as indicated in the table below.

Color	Specific Practice (%)	Generic Practice (#)
Green	90-100	6-7
Yellow	65-89	4-5
Red	0-64	0-3

The formats provided below are recommended and viewed as essential to promote standardization across the AF. The information contained in each is notional. Additional views may be added as leadership determines necessary.

6.2. Project/Program Level Recommend Reporting Format

Specific Practices

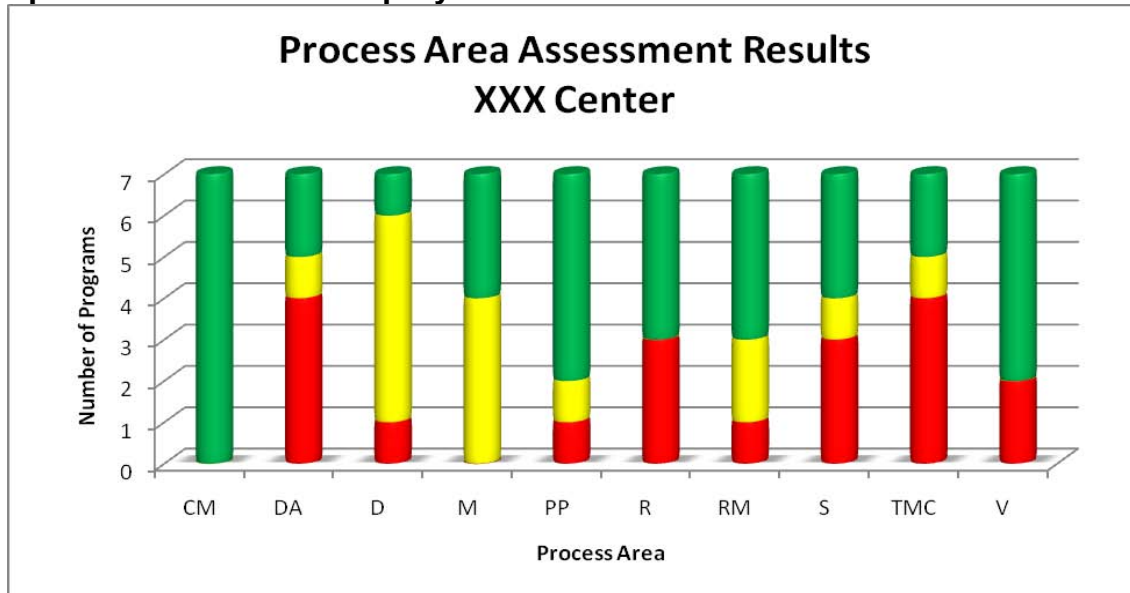
Percentage (of those practices scored)		75%	50%	79%	73%	87%	86%	100%	67%	83%	93%
		CM	DA	D	M	PP	R	RM	S	TMC	V
Specific Goal 1											
SP 1.1		1	1	1	0	1	1	1	1	1	1
SP 1.2		1	1	1	1	1	1	1	1	1	1
SP 1.3		0	1	1	1	1	1	1	1	1	1
SP 1.4			N/A	0		1	1			1	1
SP 1.5			0	0						1	
Specific Goal 2											
SP 2.1		1		1	1	0	1	1	0	1	1
SP 2.2		1		0	1	0	1	1	0	1	1
SP 2.3		0		1	1	1	1		0	1	
SP 2.4		0		1		1			0		
SP 2.5		N/A				1			0		
SP 2.6						1					
SP 2.7						1					
SP 2.8						1					
Specific Goal 3											
SP 3.1		1		1	1	1	1	1	1	0	1
SP 3.2		1		1	1	1	0	1	1	0	1
SP 3.3				1	1	1	0			1	0
SP 3.4				1						1	
SP 3.5				1							
Specific Goal 4											
SP 4.1					1		1		1		1
SP 4.2					0		1		1		1
SP 4.3					0		1		1		1
SP 4.4							1		1		1
SP 4.5									1		1
Specific Goal 5											
SP 5.1											N/A
SP 5.2											N/A

Generic Practices

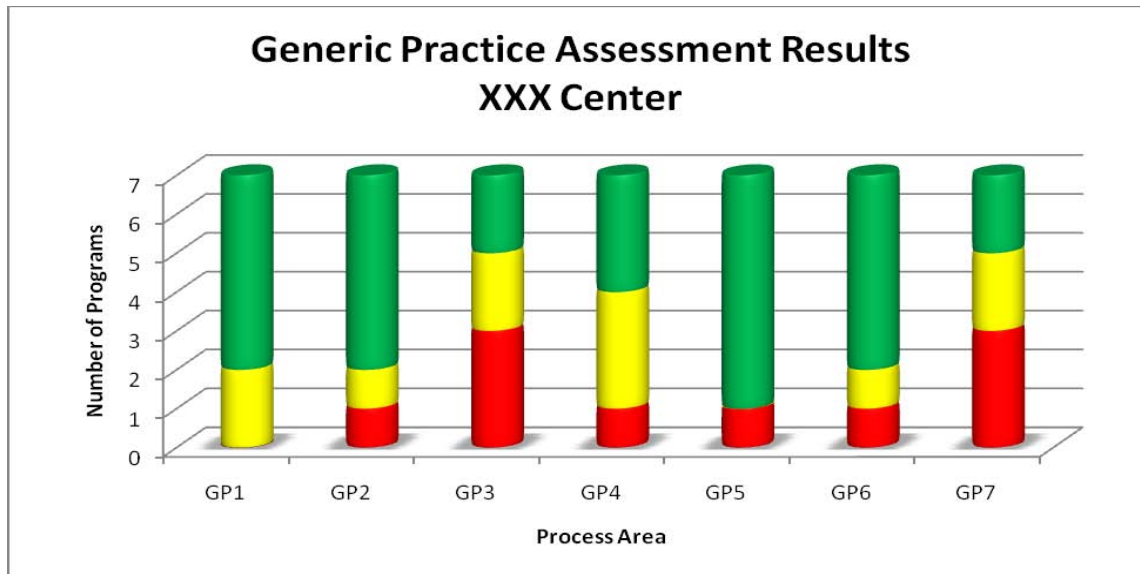
PA/GP	GP1	GP2	GP3	GP4	GP5	GP6	GP7	GP Overall
CM	1	1	1	1	1	1	1	7
DA	0	0	1	1	1	1	1	5
D	1	1	1	1	1	1	1	7
M	1	1	1	1	1	1	1	7
PP	0	1	1	0	1	0	1	4
R	1	1	1	1	1	1	1	7
RM	1	1	1	1	1	1	0	6
S	1	1	1	1	1	1	1	7
TMC	0	1	1	1	1	1	1	6
V	1	1	1	1	1	1	1	7

6.3. Center & MAJCOM Level Recommend Reporting Format

Specific Practices Roll Up By Process Area



Generic Practices Roll Up By Process Area



7. Training

There are three different training modules that have been specifically designed to support AF SEAM: *Leadership*, *Self-Assessment*, and *Independent Validation Training*. Training is provided as part of the AF SEAM Tool Suite.

7.1. AF SEAM Leadership Training

Leadership training is designed to take approximately one hour and is specifically designed for members of leadership/management who oversee projects/programs, or have responsibility for their oversight.

7.2. AF SEAM Self-Assessment Training

AF SEAM Self-Assessment training is specifically designed for those who will be performing a self-assessment using the AF SEAM. This training introduces the participant to AF SEAM, the assessment process, the details of its construction, the basic principles of continuous process improvement, and the importance of their role as a process participant. It also outlines the goals of AF SEAM and demonstrates results reporting in that context. The participant is taken through various exercises to provide advance “hands-on” training to assist in becoming comfortable with using AF SEAM, and to simultaneously promote standardization of reporting. Training is designed to take approximately 4 hours, is provided in person by an individual who is intimately familiar with and experienced in the use of AF SEAM, and is intended to be given “just-in-time”.

7.3. AF SEAM Validation Assessment Team Training

AF SEAM Validation-Assessment training is specifically designed for those who will be members of an AF SEAM validation assessment team. In addition to briefly covering the materials contained in the self-assessment training, emphasis will be on their specific roles and responsibilities as they relate to the assigned task. Therefore, the training is tailored to meet the specific needs of team members for the validation assessment being undertaken. Training is designed to take approximately 4 hours. Whenever possible, the team lead will personally conduct this training. If the team lead is not available, then the training is provided in person by an individual who is intimately familiar with and experienced in the use of AF SEAM. As with the self-assessment training, validation assessment team training is intended to be given “just-in-time”.

8. Process Areas

8.1 Configuration Management (CM)

The purpose of Configuration Management is to establish and maintain the integrity of the product's technical baseline while accommodating change and providing a clear, concise, and valid description of the product to concerned parties.

Configuration management is the process of managing products, facilities, and processes by managing the information about them, including changes, and ensuring they are what they are supposed to be in every case.

A “configuration item” is defined as an aggregation of work products that is designated for configuration management and treated as a single entity within the configuration management process.

A “baseline” is set of specifications or work products that has been formally reviewed and agreed on, that thereafter serves as the basis for further development and authoritative representation of the product.

A progression of technical baselines is developed during the development life-cycle of a product. Once the baseline is established, changes to the items can only be done through a formal change process. Baselines provide a stable basis for continuing evolution of configuration items. An example of a baseline is an approved description of a product that includes internally consistent versions of requirements, requirement traceability matrices, designs, and end-user and support documentation.

The Configuration Management process area can best be described by the following goals and practices.

CMG1 The approach for technical baseline management is defined and documented.

CMG1P1 Identify accountability for the disposition of, access to, release of and control of the technical baselines.

Description: Establish and maintain a strategy for technical baseline management. Specify which configuration items will be controlled during the various phases of product development i.e., what baselines will be established and when. Define the membership of the configuration control boards. Define which members will have authority to access and release design and product baselines, and authorize changes to the baselines as the product progresses through its life cycle.

Typical Work Products:

- ☐ Systems Engineering Plan
- ☐ Configuration Control Board Charter

Reference Material: DI-CMAN-80858 B,

Other Considerations:

CMG1P2 Establish and maintain plans for managing the configuration of the product.

Description: Document plans and processes for technical baseline management in appropriate documents. Describe how consistency between the product definition, the product's physical and functional configuration, and the CM records is achieved and maintained throughout the product's life cycle.

Typical Work Products:

- ☐ Systems Engineering Plan
- ☐ Configuration Management Plan

Reference Material:

Other Considerations: Consider the project's related needs for management of data and interfaces. Configuration management addresses obsolescence and technology refreshment. Change management process includes a checklist for all changes to be evaluated for impact to the OSS&E Baseline Document. Configuration management of products may be documented in the Systems Engineering Plan or the Configuration Management Plan.

CMG2 Establish and maintain technical baselines while managing change.

CMG2P1 Identify the configuration items and related work products that will be placed under configuration management.

Description: Select the configuration items and work products that define them. Assign unique identifiers to each configuration item. Identify the important functional and physical attributes. Specify control characteristics for each item (e.g., organization responsible, degrees of control and when the item should be placed under configuration management).

Typical Work Products:

- ☐ Configuration Management Plan
- ☐ Configuration Items (list, table, spreadsheet etc.)

Reference Material: AFI 33-114, Air Force Weapon Systems Software Management Guidebook, MIL-HDBK-61A

Other Considerations: Examples of work products that may be a part of a configuration item include process descriptions, requirements, design details, verification methods and procedures, source code and tools. Other documents, such as interface definitions and test results, may also be included.

CMG2P2 Establish and maintain configuration and change management systems.

Description: The configuration and change management system enables the disciplined management and control of changes to the product and related work products.

Typical Work Products:

- ☐ Configuration management system with controlled work products
- ☐ Configuration management system access control procedure
- ☐ Change request database

Reference Material: AFI 33-114, MIL-HDBK-61A, Air Force Weapon Systems Software Management Guidebook

Other Considerations: The configuration management system includes the storage media, the procedures, and the tools for accessing the configuration system. It also includes the storage media, the procedures, and the tools for recording and accessing change requests. The system should be able to retrieve documentation of any baseline and status of all CM actions

CMG2P3 Create or release technical baselines.

Description: Ensure that all baselines established are created from configuration items described within the configuration management system, documented, authorized and released in accordance with CM plans.

Typical Work Products:

- ☐ Description of baselines

Reference Material: AFI 33-114, MIL-HDBK-61A, Air Force Weapon Systems Software Management Guidebook

Other Considerations: One common set of baselines includes the product-level requirements, product-element-level design requirements and the product definition at the end of development/beginning of production. These are typically referred to as the functional, allocated, and product baselines. The baselines correlates with the system work breakdown structure (WBS) and refer to both functional and physical/product baselines.

CMG2P4 Track and control changes.

Description: Track the status of change requests to closure. Determine the impact that the change will have on the product, related work products, use of the product, logistics support, schedule and cost. Maintain control over the configuration of the work product baseline. This control includes tracking the configuration of each of the configuration items, approving a new configuration if necessary, and updating the baseline. Maintain the integrity and traceability of the configuration throughout the product life cycle.

Typical Work Products:

- ☐ Change requests
- ☐ Revision history
- ☐ Baseline archives

Reference Material: Air Force Weapon Systems Software Management Guidebook

Other Considerations: Change requests address not only new or changed requirements (e.g., due to obsolescence, and technology refreshment), but also failures and defects in the work products.

CMG3 *Integrity of baselines is established and maintained*

CMG3P1 Establish and maintain records describing configuration items

Description: Ensure that configuration information permits forward and backward traceability to other baselined configuration states.

Typical Work Products:

- ☐ Revision history of CIs
- ☐ Change log
- ☐ Change request records
- ☐ Status of CIs
- ☐ Differences between baselines

Reference Material: AFI 33-114, Air Force Weapon Systems Software Management Guidebook, MIL-HDBK-61A

Other Considerations: Records include revision history of configuration items, change log, copy of change requests, status of configuration items, and differences between baselines.

CMG3P2 Perform configuration audits to maintain integrity of the configuration baselines

Description: Audit configuration management activities and processes to confirm that the resulting baselines and documentation are accurate, and record the audit results as appropriate.

Typical Work Products:

- ☐ Configuration audit results
- ☐ Action Items to address discrepancies

Reference Material: Air Force Weapon Systems Software Management Guidebook, MIL-HDBK-61A

Other Considerations: Functional Configuration Audits are used to verify that the configuration item has achieved the performance requirements as specified in its functional configuration identification documents. Physical Configuration Audits are the formal examination of as-built or as-coded configurations to ensure that products produced and processes used match the approved baseline documentation. Approach audits as a series of rolling reviews in which items are progressively audited.

8.2 Decision Analysis (DA)

The purpose of Decision Analysis is to analyze possible decisions using a formal process that evaluates identified alternatives against established criteria.

A repeatable criteria-based decision-making process is especially important, both while making the critical decisions that define and guide the acquisition process itself and later when critical decisions are made with the selected suppliers. The establishment of a

formal process for decision-making provides the acquisition project with documentation of the decision rationale. Such documentation allows the criteria for critical decisions to be revisited when changes that impact project requirements or other critical project parameters change.

The Decision Analysis process area can best be described by the following goals and practices.

DAG1 Base decisions on an evaluation of alternatives using established criteria

DAG1P1 Establish and maintain guidelines to determine which issues are subject to a formal evaluation process

Description: Define thresholds and authorities for controlling resolution of issues subject to a formal evaluation process in the guidelines.

Typical Work Products:

- ☐ Guidelines

Reference Material: AFI 63-1201

Other Considerations: Not every decision is significant enough to require a formal evaluation process. The choice between the trivial and the truly important may be unclear without explicit guidance. The significance of a particular decision is dependent on the project and circumstances and is determined by the established guidelines. Ensure relevant technical issues are brought to the designated SE technical authority as part of the acquisition decision process.

DAG1P2 Establish and maintain the criteria for evaluating alternatives, the relative ranking of these criteria, and select the evaluation methods

Description: Consider solution costs, risks, technology limitations, and impact on established baselines and/or operational functions in the criteria. Include rationale, range, and scale of values, and coordinate with appropriate stakeholders.

Typical Work Products:

- ☐ Evaluation criteria and methods (e.g. Decision analysis record, acquisition strategy, etc.)

Reference Material: AFI 63-101

Other Considerations: Regular use of decision-making criteria, even for less significant decisions, can be extremely helpful in creating a practice for disciplined decision making. Practiced evaluators have demonstrated that defined criteria and weighting can be significant contributors to the speed and consensus level of a decision. Decision-making criteria may apply at two distinct levels, i.e., at the project level where criteria may be due to project priorities, and at the issue level where different criteria may be appropriate for each specific issue. The decision making method that best focuses on the issue(s) should be selected giving consideration to impact on cost, schedule, performance, and risk. Two or more methods may be indicated if the consequences of a poor decision are high. The evaluator may select from methods including Cost Study/Cost Model, Simulation/Prototype, Manufacturing Study, Engineering/Benchmark/Trade Study, Business Opportunity Study, Extrapolation based on experience or study, User Review and Comment, Testing, Data Comparison, Feature Comparison, Decision Tool (e.g.,

tool for Monte Carlo simulation for distribution of uncertainty in choices), Modeling Tool, and others. Stakeholders and project management should concur with selected methods.

DAG1P3 Identify alternative solutions to address issues

Description: Document the alternative solutions and include rationale for including or rejecting any alternatives for consideration.

Typical Work Products:

- ☐ Analysis of Alternatives (AoA)

Reference Material:

Other Considerations: A wider range of alternatives can surface by literature search on the applicable issue and by soliciting as many stakeholders as practical for input. Input from stakeholders with diverse skills and backgrounds can help teams identify and address assumptions, constraints, and biases. Brainstorming sessions, with support from the stakeholders, may stimulate innovative alternatives through rapid interaction and feedback. Additionally to stakeholders, human system integration experts can review alternatives for usability, safety, survivability and with respect to other human requirements and considerations. HSI reviews and recommendations during AOA help handle risk and reduce life cycle costs.

DAG1P4 Evaluate alternative solutions using the established criteria and methods

Description: Document scoring and conclusion(s), using selected evaluation methods and established criteria. Document unknowns or assumptions made about the solution, including observations that support or disprove those assumptions. Identify, evaluate, and document new alternatives along with rationale in cases where all current alternatives prove unsatisfactory. Identify changes to evaluation criteria. Use iterative analysis as necessary.

Typical Work Products:

- ☐ Meeting minutes

Reference Material:

Other Considerations:

DAG1P5 Select the solution(s) from the alternatives and document decisions based on the evaluation

Description: Document the recommended solution(s), data, associated risks, and rationale for selection. Document and present any dissenting opinions. Review results of evaluation with stakeholders and project management for concurrence. Document the final decision with associated rationale and risks.

Typical Work Products:

- ☐ Decision analysis record

Reference Material:

Other Considerations:

8.3 Design (D)

The purpose of Design is to conceive and proof an integrated solution that satisfies product requirements. Solutions, designs, and implementations encompass products, product components, and product-related life-cycle processes either singly or in combinations as appropriate. Beyond the level of the product design where responsibility has been assigned to suppliers, it is the acquirer's role to oversee the adequacy of the supplier's process for requirements allocation and product-component design.

The Design process area focuses on product design, initial implementation and integration. As each level of the product is defined, there is an iterative process of allocation, high-level design, and requirements definition (for the next-lower level).

Product design consists of two broad phases that may overlap in execution: preliminary and detailed design. Preliminary design establishes product capabilities and the product architecture, including product partitions, product-component identifications, product states and modes, major inter-component interfaces, and external product interfaces.

Detailed design fully defines the structure and capabilities of the product components. During detailed design, the product architecture details are finalized, product components and interfaces are completely defined (detailed in the context of containing all the information needed to manufacture, code, or otherwise implement the design as a product or product component).

Product integration is achieved through progressive assembly of product components, in one stage or in incremental stages, according to a defined integration sequence and procedures. A critical aspect of product integration is the management of interfaces to the products and between product components to ensure compatibility among the interfaces. Attention should be paid to interface management throughout the project.

Product integration can be conducted incrementally, using an iterative process of assembling product components, evaluating them, and then assembling larger collections of components. This process may begin with analysis and simulations (e.g. virtual prototypes and rapid prototypes). In a succession of builds, the simulated product is constructed, evaluated, improved, and reconstructed based upon knowledge gained in the evaluation process.

The Design process area can best be described by the following goals and practices.

DG1 The design is based upon a documented architecture, traceable to requirements, and optimized for the set of requirements and constraints

DG1P1 Establish and maintain the architectural design baseline

Description: Develop logical and physical views of the product that model the functionality to be performed along with the required component relationships. Design considerations should include ease of change, technology transparency and mitigating the risk of component obsolescence. Consider the use of simulation to explore alternative models, derive other requirements and better communicate needed

product characteristics. Iteratively as the layers of the product architecture are defined the product's required functionality should be allocated to the components. Periodically conduct architecture evaluations to confirm the continued suitability of the product architecture. Review the computing system architecture to ensure robustness, fault tolerance, reserve capacity and growth are addressed.

Typical Work Products:

- ☐ DoDAF views
- ☐ Interface descriptions
- ☐ Top level engineering drawings
- ☐ Computer System & Software architectures

Reference Material:

Other Considerations:

DG1P2 Establish and maintain interface designs

Description: Define the logical, physical, and human interfaces for the product and between product-components. Managing product and product-component interfaces must start very early in the development of the product. The definition and control of interfaces affects requirements allocation, product design, manufacturing, integration and verification. Make use of acceptable standards. Consider interface requirements and product partitioning to facilitate: incorporation of security technologies, design robustness and replacement of obsolescent parts (e.g., military grade global positioning system receivers).

Typical Work Products:

- ☐ Interface design documents
- ☐ ICWG charter and minutes

Reference Material:

Other Considerations:

DG1P3 Establish and maintain design artifacts that describe the conditions, functions, operating modes, and operating states specific to the components of the architecture

Description: Document the interaction of the product-components with the environment, other systems, and end users including modes and operating states for a particular component or set of components. Select among alternatives and refine the architecture that, when implemented, will satisfy the intended use of the product. Use modeling, analysis, and verification techniques to the maximum extent feasible.

Typical Work Products:

- ☐ Operational use cases
- ☐ Sequence and collaboration diagrams
- ☐ State charts or diagrams

Reference Material:

Other Considerations:

DG1P4 Develop potential product-component solutions, alternatives, and selection criteria

Description: Base alternatives on potential product architectures. Explore design space of feasible solutions. Use robust engineering processes to ensure a quality and flexible product. Identify the key factors and selection criteria that provide a basis for the solution (e.g., design for manufacturing, supportability, and reliability). Identify criteria that provide clear discrimination and an indication of success in arriving at a balanced solution across the life of the product. Include measures of cost, schedule, performance, supportability, and risk.

Typical Work Products:

- ☐ Technical review(s) entry & exit criteria
- ☐ Allocated baseline
- ☐ Selection criteria

Reference Material: IEEE/EIA 12207, MIL-HDBK-514

Other Considerations: Modeling, simulation and analysis techniques can be used to identify and minimize product design failure modes during the initial design phases.

DG1P5 Analyze and select product-component solutions that best satisfy the established criteria

Description: Develop a modeling and simulation activity to evaluate potential solutions in a simulated operational context, wherever feasible. As selections are made, the design space may be constricted and other alternatives examined until the most promising (i.e., optimal) solution that meets requirements and criteria is identified. Document the description of the alternative solutions and the rationale for selection.

Typical Work Products:

- ☐ KPPs
- ☐ Interfaces
- ☐ M&S results
- ☐ Trade studies w/ AoAs
- ☐ Critical Operational Issues (COIs)
- ☐ TPMs
- ☐ Reliability & Maintainability Analysis
- ☐ Usability Analysis

Reference Material:

Other Considerations:

DG2 *Develop and document a detailed design and implementation strategy*

DG2P1 Establish initial product-component designs and development strategies

Description: Define the structure and capabilities of the product-components. Use lower level requirements generated from the selected alternatives to develop the detailed component design. Detail the logical and physical interfaces between product-components. Develop the key product/design characteristics including: anti-tamper, materials, fabrication, logistics support, and manufacturing requirements and processes. Identify constraints on implementation. Consider technology maturity and manufacturing readiness as potential areas for risk mitigation and/or product evolution.

Typical Work Products:

- ☐ Development hardware and software specifications
- ☐ WBS (Work Breakdown Structure)
- ☐ TRA (Technology Readiness Assessment)
- ☐ MRA (Manufacturing Readiness Assessment)
- ☐ Bill of materials
- ☐ ILSP (Integrated Logistics Support Plan)

Reference Material: MIL-STD-881, MIL-HDBK-881, AFI 63-1201

Other Considerations:

DG2P2 Evaluate whether the product-components should be developed, purchased, or reused based on established criteria

Description: Determine what products or product-components will be acquired – this is frequently referred to as a make-or-buy analysis. It is based on an analysis of the needs of the project. Perform industrial base analysis for critical products and product-components. Analyze cost, schedule, and performance risks when evaluating commercial off-the-shelf (COTS) product-components

Typical Work Products:

- ☐ Make-or-buy analysis
- ☐ Industrial base analysis (to include diminishing manufacturing sources)

Reference Material: AFI 63-101, AFI 21-118, SD22, DI-SESS-81656, GEB1

Other Considerations: The make-or-buy analysis begins early in the project during the first iteration of design, continues during the design process, and is completed with the decision to develop, acquire, or reuse the product.

DG2P3 Establish detailed designs for the product-component.

Description: Develop the key product/design characteristics and associated manufacturing processes including materials (bills of material and material characteristics), fabrication and manufacturing requirements (for both the original equipment manufacturer and new supplier, and field product support.

Typical Work Products:

- ☐ PHS&T documentation
- ☐ TDP (Tech Data Package)
- ☐ CDR entry and exit requirements, and action item closure
- ☐ Final bill of materials
- ☐ Manufacturing plan

Reference Material: MIL-STD-2073, AFI 63-501, MIL-STD-1528A, AFI 63-1201

Other Considerations: The detailed design results in the specification of each of the components at all levels of the hierarchy. It addresses each of the key factors that provided a basis for the selection of the solution (e.g. design for manufacturing, supportability, producibility, reliability, safety, packaging and handling, etc). A review (traditionally a CDR) process is used during design to include both hardware and software design to demonstrate that the allocation of requirements achieve an effective system. This activity includes the allocation, refinement and production of the product-components, which can be accomplished using the planned manufacturing tools, processes, and personnel. It also includes the coordination between the various product-component development efforts to refine internal interface specifications.

DG2P4 Establish and maintain a technical data package

Description: Develop a comprehensive technical data package for the product or product-component to support development and sustainment.

Typical Work Products:

- ☐ Installation Plan
- ☐ User Manual
- ☐ TO (Technical Orders)
- ☐ Training Manual
- ☐ TCTO (Time Compliance Technical Orders)
- ☐ Digital System Models
- ☐ TDP (Technical Data Package)
- ☐ Software Requirements, Design, and Verification Documentation

Reference Material:

Other Considerations:

The technical data package usually includes the following:

- Component design and life-cycle process descriptions,

- Key product/design characteristics including functional responsibilities, logical and physical interface requirements,
- Rationale for decisions and characteristics (requirements, requirement allocations, and design choices),
- Materials, fabrication and manufacturing requirements (for both the original equipment manufacturer and field support),
- The verification criteria used to ensure that requirements have been achieved and
- End user documentation that will be used to install, operate, and maintain the product.

The technical data package may also contain conditions of use (environments) and operating/usage scenarios, modes and states for operations, support, training, manufacturing, disposal, and verifications to be used throughout the life of the product.

DG3 Assemble the design/development prototype(s) in accordance with the detailed design and integration strategy.

DG3P1 Establish and maintain the product integration approach

Description: Define and document assembly procedures and sequences that minimize product integration risks. Identify any constraints on the design arising from the integration strategy. Consider requirements for test equipment, test software, or other integration items such as fixtures. Periodically review the product integration sequence and revise as needed.

Typical Work Products:

- ☐ Assembly procedures and sequences
- ☐ Interface drawings and documents
- ☐ Integration and test documents
- ☐ TCTO (Time Compliance Technical Orders)
- ☐ System Integration Plan
- ☐ Digital System Models

Reference Material: AFI 99-103, AFI 63-107, T.O. 00-5-1

Other Considerations:

DG3P2 Establish and maintain procedures and criteria for integration of the product-components

Description: Procedures for the integration of the product-components can include such things as details of the expected tests and other evaluations to be carried out at each stage. Criteria can indicate the readiness of a product-component for integration or its acceptability. Assure component compatibility with the integration environment. Provide sufficient data to support certifications.

Typical Work Products:

- ☐ Product and product-component certifications
- ☐ Integration and test documents

Reference Material: AFI 99-103, AFI 63-107

Other Considerations:

DG3P3 Manage internal and external interface definitions, designs, and changes for products and product-components

Description: Periodically review all interface descriptions for coverage and completeness. Effective management of product-component interface requirements, specifications, and designs helps ensure that implemented interfaces will support integration.

Typical Work Products:

- ☐ Assembly procedures and sequences
- ☐ Interface drawings and documents
- ☐ Integration and test documents
- ☐ TCTO (Time Compliance Technical Orders)
- ☐ Digital System Models

Reference Material: AFI 99-103, AFI 63-107

Other Considerations: Many product integration problems arise from unknown or uncontrolled aspects of both internal and external interfaces. Participation in all relevant interface control working groups (ICWGs) helps ensure that implemented interfaces will support integration.

DG3P4 Conduct, prior to assembly product-component verification

Description: Ensure that each product-component required to assemble the product has been properly identified, functions according to its description, and that the product-component interfaces comply with the applicable interface definition. Develop and document key assembly and tightly coupled test techniques during first article production for use in subsequent full-rate production.

Typical Work Products:

Reference Material:

Other Considerations:

DG3P5 Assemble product-components according to the product integration sequence and established procedures

Description: Acceptance or readiness to test criteria defined during design and integration are satisfied. This assessment can also be performed as appropriate for different stages of assembly of components as identified in the integration sequence and available procedures.

Typical Work Products:

Reference Material:

Other Considerations:

8.4 Manufacturing (M)

The purpose of the Manufacturing process is to prepare for and produce the required product.

The Manufacturing process area includes: application of industrial base and manufacturing process expertise and information to Requirements and Design processes; planning for and managing the manufacturing process maturation efforts needed for successful transition from product development to rate production; and then stabilizing a sustained rate production while assuring affordable quality products. Clear manufacturing readiness criteria should exist for each phase of the project and be agreed to by relevant stakeholders. Manufacturing readiness assessments (MRA) should be conducted to confirm manufacturing readiness at key points in the project. Manufacturing transition plans are established to address the manufacturing readiness criteria and executed to ensure maturation of manufacturing capability. The residuals of manufacturing (e.g. facilities, processes, tooling and test equipment) should be integrated into the support infrastructure required for the remainder of the product life cycle.

The Manufacturing process area can best be described by the following goals and practices.

MG1 Prepare for manufacturing

MG1P1 Establish and maintain strategy and plans for manufacturing

Description: Describe the anticipated approach for producing the end-item, including purchasing material, parts, and subassemblies and in-house fabrication, assembly, and test. Describe the resources needed (tooling, test equipment, facilities, manpower, and special skills) and the plans for acquiring them. Describe the supplier management procedures, the major/critical suppliers, the Quality Management System, and the controls established to ensure conforming products. Describe the metrics and predictive indicators that will be used to assess manufacturing cost, schedule, and quality performance, including the performance of key suppliers. Describe all production-related activities that must be accomplished to ensure a smooth transition from development to rate production. Describe an integrated strategy for design and manufacturing engineering, capital investment and personnel recruiting and retention. Define strategies for control and flow down of policies, process and practices to sub-tier suppliers.

Typical Work Products:

- ☐ Manufacturing plan

Reference Material: AFI 63-501, DoDI 5000.02, AFI 63-1201

Other Considerations: The manufacturing strategy should be based on an assessment of current manufacturing capabilities and a realistic plan for development of any required new capabilities. The manufacturing plan defines the approach for producing a product configuration including all actions that are required to produce, test and deliver an acceptable product on schedule and at minimum cost. Procedures for the integration of the product components should include acceptability criteria and details of the verification tests to be carried out at each stage. The manufacturing plan should address product delivery schedules, make-or-buy decisions and manufacturing resource requirements (e.g., facilities, tooling, capital equipment, personnel). The materials, fabrication flow, time in process, tools, test equipment, plant facilities, and personnel skills should be described and integrated into a complete sequence and schedule of events. It is essential that the suppliers be considered in the planning.

MG1P2 Perform concurrent design and manufacturing engineering

Description: Develop and obtain approval on the factory verification plan and realistic production-rate analysis before the design configuration is frozen. Conduct producibility studies and ensure they include either an evaluation of the capabilities of the manufacturing processes to meet design requirements or approaches to improve the product's ease of manufacturing. Manufacturing engineers sign-off on engineering drawings as part of the design approval process to ensure that the product can be manufactured economically.

Typical Work Products:

- ☐ Factory verification plan
- ☐ Producibility studies
- ☐ Production readiness analysis
- ☐ Engineering drawings

Reference Material: AFI 63-501

Other Considerations: Concurrent engineering is a key factor in improving the quality, development cycle, production cost, and delivery time of products. It focuses on designing the manufacturing processes, tooling and special test equipment at the same time as the product is designed. Design for Manufacturing (DFM) is an activity accomplished through the collaboration of many disciplines including design and manufacturing engineers and technicians. Product designers must understand manufacturing operations and support development of manufacturing processes and procedures to ensure that the product can be manufactured efficiently and economically.

MG1P3 Establish and maintain manufacturing technical data

Description: Define critical manufacturing processes and procedures, their key characteristics and the metrics by which their effectiveness will be measured. Describe the production test requirements, pass/fail criteria, trend analysis methods, and archival requirements.

Typical Work Products:

- ☐ Critical manufacturing processes and procedures
- ☐ Drawings, parts lists, process flow charts including inspection operations, production documents (e.g., manufacturing plans, travelers, routers, work orders, process cards, etc.) and inspection documents
- ☐ A list of tools and numerical control machine programs required and any specific instructions associated with their use

Reference Material:

Other Considerations:

MG2 Transition from development to repeatable and economical production at desired rate

MG2P1 Establish and maintain plans for transition to production

Description: Describe an integrated strategy for design and manufacturing engineering, capital investment and personnel recruiting and retention. Include provisions to ensure that manufacturing personnel influence the design process to ensure the final configuration is capable of being economically produced at the desired rates and with adequate quality. Prepare a transition plan to be used by the suppliers during the early phases of development to support tradeoff decisions which can have a significant impact on production.

Typical Work Products:

- ☐ Transition plan

Reference Material:

Other Considerations: The transition to production plans are comprehensive management plans that describe all production-related activities that must be accomplished during design, test, and low-rate initial production to ensure a smooth transition from development to rate production.

MG2P2 Qualify/proof manufacturing processes, special tools and test equipment

- ☐ **Description:** Ensure production planning, tool design, assembly methods, finishing processes, personnel training and special processes (e.g. one-time inspection or test that can not be verified later in the process) are performed before rate production at the integrator and major supplier facilities. Document qualified manufacturing processes and place them under configuration control. Establish proof of production processes where the resulting output (e.g. single-shot device, bomb fuse, or satellite) cannot be verified by subsequent monitoring or measurement.

Typical Work Products:

- ☐ Manufacturing process documentation
- ☐ Special process documentation

Reference Material:

Other Considerations: As early as possible in development, proof of manufacturing models should be used to establish that planned production processes and procedures are compatible with the design. Development hardware should be produced using production processes and procedures to the maximum extent possible.

MG2P3 Ensure readiness for manufacturing

Description: Ensure readiness for manufacturing by performing Manufacturing Readiness Assessments (MRA) and Production Readiness Reviews (PRR). Ensure the assessment verifies a product baseline (e.g., qualified and controlled drawings and process specifications) that can be produced consistently with the facilities, tooling, processes, and personnel available within the production budget/schedule. Ensure the assessment identifies manufacturing/quality risks, potential metrics, and produces a manufacturing readiness level (MRL).

Typical Work Products:

- ☐ MRA
- ☐ PRR report or briefing

Reference Material:

Other Considerations: MRAs can determine the adequacy of the manufacturing processes, the Quality Management System, and the production plans. PRR criteria address the evaluation of design maturity, critical manufacturing process capabilities, expected variability, critical spares, product acceptance criteria, tooling, test equipment, personnel, quality controls to ensure conforming products, supplier readiness and capabilities, production cost estimates, and manufacturing risks throughout the supply chain. Production Readiness Review planning is completed with entry and exit criteria established.

MG3 Manufacture the product in accordance with plans and specifications

MG3P1 Ensure that production at desired rates is conducted according to the plan

Description: Ensure the manufacturing processes and procedures adhere to the approved plan(s) to provide a uniform, quality product with consistent performance. Track and report metrics to maintain insight into the manufacturing operations (e.g. actual hours per ship set or lot, realization or efficiency, traveled work, cycle time, scrap/rework/repair, cost of quality, process capabilities (Cpk), MRB dispositions, quality escapes, and first pass yields).

Typical Work Products:

- ☐ Work control document
- ☐ Process control charts
- ☐ Statistical analyses

Reference Material:

Other Considerations: Take advantage of Defense Contract Management Agency (DCMA) processes and personnel as much as possible.

MG3P2 Establish and maintain inventory and supplier management/control

Description: Establish a supplier management program to:

- Communicate project requirements with the suppliers,
- Assure that manufacturing readiness levels at key suppliers support project needs,
- Assure supplier compliance with requirements,
- Address risks associated with transferring work between facilities,
- Identify and manage supplier risks and
- Continuously assess overall health of the supply-chain

Perform site visits to assure process plans are documented and followed to ensure that the chosen supplier(s) can perform. Make follow-up visits to control process drift. Conduct conferences tailored to educating each supplier on their contract as well as the key technical elements of the overall project.

Typical Work Products:

- ☐ Supplier management plan
- ☐ Inventory control plan
- ☐ Risk matrix

Reference Material:

Other Considerations: Good communication among the acquirer and suppliers is a key ingredient in effective supply-chain management. The project team should consider using a dedicated, multi-discipline onsite evaluation team (including representatives from production, quality, material, technical, and configuration management) to ensure completeness and consistency of specifications, procurement packages, technical interfaces, and flow down of requirements to the suppliers. The type and extent of control applied to the supplier and the purchased product should be dependent upon the effect of the purchased product on the final product.

MG3P3 Complete First Article Inspection (FAI)

Description: Conduct FAI (inspection and verification) on a representative item from the first production run of a new part, or following any change that invalidates the previous first article inspection result. Subject the first article to a formal examination (e.g., Physical Configuration Audit (PCA)) to ensure the as-built configuration matches the draft technical data package and also validates supporting production processes.

Typical Work Products:

- ☐ FAI report
- ☐ PCA minutes
- ☐ Action items

Reference Material:

Other Considerations:

MG4 Product and process quality is assessed and improved

MG4P1 Establish and maintain piece part control and perform manufacturing screening

Description: Flow down requirements to suppliers and require a formal parts control program during development. Develop testing and screening programs at the suppliers' facilities, and receiving inspection at the integrators' facilities. Monitor the supplier's performance by yield.

Typical Work Products:

- ☐ Test plans/procedures
- ☐ Parts control program plan

Reference Material:

Other Considerations: A key element of parts control is an established corporate policy which ensures that certain steps are taken to control part quality (both electrical and mechanical), independent of government contract requirements. Environmental stress screening (ESS) should be designed during the development phase.

MG4P2 Establish and maintain a quality management system

Description: Establish and maintain manufacturing processes. Monitor and control critical processes and product variation. Establish mechanisms for feedback of field product performance. Implement a root cause analysis and corrective action system. Apply continuous process improvement practices. Establish processes and procedures for ensuring implementation of these activities at all supplier levels.

Typical Work Products:

- ☐ Deficiency reporting system
- ☐ Quality Assurance Plan

Reference Material: AFI 63-501

Other Considerations: A key aspect to consider is how process changes will be accepted, authorized, documented, and implemented to establish and maintain the desired quality.

MG4P3 Establish and maintain defect control

Description: Design products, manufacturing processes and tooling to minimize the potential for incorrect manufacturing and assembly (i.e., poka-yoke or fool proofing). Establish deficiency feedback, root cause analysis, and corrective action mechanisms. Establish a corrective action team to ensure adequate attention to the causes of defects. Develop criteria, processes and procedures for determination and disposition of nonconforming products to prevent its unintended use or delivery.

Typical Work Products:

- ☐ Deficiency reporting system
- ☐ Root cause and corrective action analysis

Reference Material: T.O. 00-35D-54

Other Considerations: Management commitment to a culture of defect “prevention” is the essence of defect control.). An automated defect reporting/tracking system can enhance timely analysis of problem areas and verification of effectiveness of action taken to correct problems. TO 00-35D-54 describes the deficiency reporting, investigation, and resolution process for USAF products. Process Failure Mode, Effects and Criticality (PFMECA) are performed to identify potential failures in critical and safety related manufacturing processes and identify actions to mitigate those potential failures.

8.5 Project Planning (PP)

The purpose of Project Planning is to establish and maintain plans that define project activities. Project Planning leads project members to think about and define all the activities required to achieve the goals of the project. Typical activities include defining the formal procedures to be used, such as the creation of documents, diagrams, or meetings to discuss the important issues, the objectives to be met, and the strategies to be followed and an understanding of roles and responsibilities.

Planning starts by aligning the technical activities with the acquisition strategy and is followed by planning technical activities in ever-increasing levels of detail. The resulting plans should be reviewed for consistency with the overall acquisition plans. The acquirer's and suppliers' project planning processes are continuous, and the plans evolve to meet the project's needs.

This area relates the technical objectives for the acquisition, the constraints, availability of assets and technologies, accommodation of end user considerations, consideration of risk, and technical support for the project over the life cycle.

If an existing product is to be replaced as part of the effort, the acquirer may be required to consider transition from operation and the demilitarization/disposal of the existing product as part of the technical planning for executing the new product.

The Project Planning process area can best be described by the following goals and practices.

PG1 Establish and maintain estimates of project planning parameters

PPG1P1 Define the project life cycle phases, milestones, and key decision points

Description: Include in the planning, the entire known life cycle from user needs through initial and subsequent upgrades. Develop entry and exit criteria for each project milestone or key decision points.

Typical Work Products:

- ☐ Integrated Master Plan
- ☐ Integrated Master Schedule
- ☐ Life Cycle Management Plan (LCMP)

Reference Material: AFI 63-1201, DoDI 5000.02,

Other Considerations: Typical life cycle choices include single-step acquisition, evolutionary incremental, or evolutionary spiral. Consider the full collection of contracts within a project context so that an integrated approach results, rather than dealing with activities individually. This supports the project planning activities on the occasions when some elements of the acquisition or life cycle may be out of the control of a particular acquisition organization. Consider major external dependencies. All milestones and tasks are linked logically to provide a fully integrated schedule demonstrating a critical path to each event as well as towards the completion of the project itself.

PPG1P2 Establish a work breakdown structure (WBS) to organize the effort

Description: Define tasks in the WBS for the work of the project to include activities performed by the acquirer as well as the suppliers and other stakeholders to ensure the planning effort covers the full scope.

Typical Work Products:

- ☐ WBS
- ☐ Work packages

Reference Material: MIL-STD-881, MIL-HDBK-881

Other Considerations: The WBS should typically be down to the lowest level of work managed.

PPG1P3 Establish and maintain the scope of the work products and tasks that describe the project cost and schedule.

Description: Define the attributes (e.g. weight, size, software lines of code, reliability, security and resource requirements, and signature) that scope each product-component and task that are of concern to the project. Estimates of the attributes of the work products and tasks are then used to bound the budget and schedule. Conduct Integrated Baseline Reviews (IBR).

Typical Work Products:

- ☐ WBS
- ☐ Work packages
- ☐ Cost accounts
- ☐ Staffing plans
- ☐ Software build plans

Reference Material:

Other Considerations: Periodic reviews of work packages and activities are performed against allocated resources, requirements and developer plans.

PPG1P4 Establish, validate, and maintain estimates for cost and schedule

Description: Develop cost and schedule estimates of the project work products. Require independent review (i.e. sufficiency review) of the estimates by individuals external to the project to ensure that the project estimation is validated.

Typical Work Products:

- ☐ Work packages
- ☐ Cost accounts

Reference Material: Air Force Weapon Systems Software Management Guidebook, 15 Aug 2008, Version 1.0, Section 3.2, Estimating Software Size, Effort, and Schedule.

Other Considerations:

For Software:

Software development and integration effort (staff hours), cost, and schedule are estimated conservatively; account for applicable software-related risks and uncertainties (such as software size growth, software reuse erosion, unstable/incomplete requirements, developer capability, etc.); are consistent with the proposed software development approach and processes, and are established as ranges with associated

probabilities. (i.e. 10%, 50%, and 90% confidence). The software estimates have been verified to be consistent with the program budget and schedule.

PPG2 Establish and maintain integrated plans

PPG2P1 Assign responsibility for acquisition and sustainment management, support, and product enhancement.

Description: Define the roles and responsibilities of the user, acquirer, suppliers, testers and enablers for the life-cycle of the product. Ensure that relevant stakeholders are involved early in the acquisition planning processes by explicitly identifying organizational responsibility for support and enhancements. Establish necessary support agreements including details of the limitations of delegated authority. Use the USAF Mission Area Assignment Process (MAAP). Identify and maintain criteria for assigning enhancements responsibility. Use the DSOR (Depot Source of Repair) process to define the source of repair activities.

Typical Work Products:

- ☐ Life Cycle Management Plan
- ☐ Project Management Plan
- ☐ Mission assignment memos
- ☐ Source of Repair Assignment Process

Reference Material:

Other Considerations: Planning should result in a documented management plan.

PPG2P2 Establish and maintain engineering plans to accomplish project.

Description: Develop the technical plans to execute the project. Describe the approach to integrating systems engineering with overall project management efforts (e.g., risk management, verification, and logistics/supportability objectives). Describe the project's requirements and constraints, processes to be employed, approach to technical staffing and organization, baseline management, and reviews. Ensure project risks are considered in planning activities.

Typical Work Products:

- ☐ Systems Engineering Plan
- ☐ HSI Plan
- ☐ Software Development Plan
- ☐ Supportability Plan
- ☐ System Safety Plan
- ☐ Test and Evaluation Strategy (TES) and Test and Evaluation Master Plan (TEMP)

Reference Material: AFI 63-1201, Defense Acquisition Guide

Other Considerations:

PPG2P3 Plan for the management of project data.

Description: Consider how technical data, to include informal data as well as formal project data and plans, will be shared across all relevant stakeholders. Include plans for managing data within integrated teams and the infrastructure required to manage data between the suppliers, operational users, and other relevant stakeholders. Decide which project technical data and plans require version control, or more stringent configuration control, and establish mechanisms to ensure project data are controlled. Plan for how technical data, test results, project milestone events, etc, will be evaluated for release to the public or outside the project.

Typical Work Products:

- ☐ Data Management Plan
- ☐ Security Classification Management Plan

Reference Material:

Other Considerations: Consider the implications of controlling access to classified information and sensitive but unclassified information (e.g., proprietary, export controlled, source selection sensitive) and other access controlled data.

PPG2P4 Plan for necessary resources, including personnel knowledge and skills, to perform the project tasks

Description: Plan for personnel resources (e.g., acquirer, suppliers or other) for the project as well as tools, infrastructure and services required during the life of the project. Include consideration for integration and test facilities. Include orientation and training for project team and stakeholders in acquisition technical practices and the domain knowledge required to execute the project.

Typical Work Products:

- ☐ Staffing plan
- ☐ POM input
- ☐ SOW
- ☐ IMP
- ☐ Training Plan
- ☐ Test and Evaluation Strategy (TES) and Test and Evaluation Master Plan (TEMP)

Reference Material:

Other Considerations: Knowledge and skill requirements can derive from project risk. For example, if the project team is acquiring a software-intensive product, ensure sufficient expertise in systems and software engineering exists within the project team. Resource planning includes implementation of Training Systems. To effectively review and manage software acquisition activities, the project team needs expertise in acquisition, management, and software development.

PPG2P5 Plan the involvement of identified stakeholders

Description: Plan for involvement of stakeholders from other projects or communities to ensure the delivered product can perform as required in its intended environment when it has to interoperate with other products.

Typical Work Products:

- ☐ Memorandum of Agreement
- ☐ Memorandum of Understanding
- ☐ Expectation Management Agreement
- ☐ Service Level Agreement

Reference Material:

Other Considerations: Stakeholders can include operational users and project participants from test or other support communities as well as potential suppliers.

PPG2P6 Establish and maintain the technology development strategy

Description: Identify potential technology constraints and develop an approach for overcoming each constraint using appropriate mitigation approach and/or technology insertion at the appropriate time in the life cycle. Provide mechanisms for identifying technology alternatives. Plan activities and establish criteria for assessing, validating, and transitioning emerging technologies.

Typical Work Products:

- ☐ Technology Development Strategy (TDS)

Reference Material:

Other Considerations: Consider plans for parallel technology development. Inputs to the planning process include Technology Readiness Assessments and Manufacturing Readiness Assessments.

PPG2P7 Plan for product Reliability, Availability, and Maintainability (RAM)

Description: Define the activities (e.g., reliability modeling, failure modes effects and criticality analyses, accelerated life testing, reliability demonstration testing) needed to achieve and demonstrate the product RAM requirements.

Typical Work Products:

- ☐ RAM plans

Reference Material: Acquisition Sustainment Tool Kit

Other Considerations: RAM needs to address consideration of fault detection and isolation, false alarms, redundancy, degraded system management, modularity, instrumentation and monitoring, mitigation of failure modes, maintenance procedures and training, and manufacturing and quality assurance (as applicable). RAM is representative of all “-ilities” that may exist on a project.

PPG2P8 Establish and maintain an Integrated Master Plan and Integrated Master Schedule (IMP/IMS)

Description: Develop an event-driven plan that describes the events, significant accomplishments, and accomplishment criteria needed to complete the project tasks described in the work breakdown structure. Develop a schedule of events and significant accomplishments against a timescale. Develop entry and exit criteria for each project milestone or key decision points.

Typical Work Products:

- ☐ IMP
- ☐ IMS
- ☐ Entry/exit criteria

Reference Material:

Other Considerations: Consider major external dependencies. All milestones and tasks are linked logically to provide a fully integrated schedule demonstrating a critical path to each event as well as towards the completion of the program.

PPG3 Establish and maintain commitment to the technical plan

PPG3P1 Review all plans to understand commitments and ensure the technical plans and overall plans are integrated and consistent

Description: Periodically review all plans to ensure they are clear, and integrated and consistent with one another. Ensure a common understanding of the scope, objectives, roles and relationships, authority, responsibility, accountability, and control for all project technical activities.

Typical Work Products:

- ☐ All project plans

Reference Material:

Other Considerations: The project may have a hierarchy of plans (e.g., Life Cycle Management Plan, Risk Management Plan, Systems Engineering Plan, Test and Evaluation Master Plan) in addition to stakeholder plans (e.g., Operational Test, Support, Suppliers' plans). The SEP should contain references to all technical plans developed for the project (e.g. Information Support Plan, Program Protection Plan, Airworthiness Plan etc.). Ensure contractual plans implement proposed development processes and associated products (for example, ensure the IMP and IMS include appropriate software development processes as documented in the Software Development Plan)

PPG3P2 Reconcile the technical plans to reflect available and estimated resources

Description: De-scope the effort to match available resources when resources (to include personnel, facilities, stakeholders, schedule, and funding) are inadequate to accomplish the technical effort. When this is not feasible, identify and handle these risks.

Typical Work Products:

- ☐ Planning documents
- ☐ Requirements documents

- ☐ Funding documents
- ☐ IMP
- ☐ IMS
- ☐ Contract

Reference Material:

Other Considerations:

PPG3P3 Obtain commitment from relevant stakeholders responsible for performing and supporting execution

Description: Coordinate and obtain approval on major plans from relevant stakeholders. Identify needed support and negotiate commitments during plan development. Document commitments to ensure a consistent mutual understanding, as well as for tracking and maintenance.

Typical Work Products:

- ☐ Signed project plans

Reference Material:

Other Considerations: Obtaining commitment involves interaction among all relevant stakeholders (acquisition, sustainment, support, test, operations, product enhancement) both internal and external to the project. The individual or group making a commitment should have the confidence that the applicable work/support can be performed within cost, schedule, and performance constraints. Well-defined interface specifications may form the basis for some commitments.

8.6 Requirements (R)

The purpose of the Requirements process area is to develop and analyze operational user, product, and product-component requirements, to assure consistency between those requirements and the project's technical plans and work products and to manage requirements evolution through the life cycle of the product.

The requirements process has several contexts. The first context is the amalgamation and coordination of the stakeholder requirements (e.g. operational requirements) into a set of requirements that will define the scope and direction of the acquisition. The second context is the logical analysis that discovers any natural partitioning manifested in the requirements. The third context concerns the extension of the customer requirements and additional acquirer requirements derived from design activities that occur as the product matures and evolves (e.g., product characteristics, architecture requirements, component design requirements).

There is a continuous iteration developing increasingly detailed derived requirements as the multiple layers of a complex product are defined. For example, requirements flow from the stakeholders to the product, segment, sub segment, and eventually to hardware or software component levels. The responsibility for developing requirements down through the levels is generally split between the acquirer and the suppliers. The acquirer

is generally responsible for the higher levels, starting with operational requirements, and the suppliers are generally responsible for lower levels. The division of responsibilities between the acquirer and suppliers is determined for each project.

The acquirer is responsible for defining and baselining the requirements levels under its control and also monitoring the suppliers definition of the lower level requirements. The acquirer will provide direct management of acquirer-controlled requirements and oversight of suppliers' requirements management. Requirements should be managed and maintained with discipline so that changes are not executed without recognizing the impact to the project.

The Requirements process area can best be described by the following goals and practices.

RG1 Stakeholder needs, expectations, constraints, and interface requirements are collected and translated into a definition of needed product capabilities/characteristics for all phases of the life cycle.

RG1P1 Elicit stakeholder needs, expectations, constraints, and interfaces

Description: Identify all stakeholders with interest in the product. Establish mechanisms for eliciting, coordinating, and formalizing operational needs and constraints. Include non-functional requirements and other attributes such as life cycle cost, need date, design robustness, producibility, supportability, re-usability, HSI, NEPA, and demilitarization/disposition which can drive the definition of the product. High-level interface requirements for interoperability in any system of systems architecture should be considered. Identify and assess potential requirements or constraints that may evolve from treaty, statutory, or regulatory considerations.

Typical Work Products:

- ☐ Stakeholder lists
- ☐ MOUs & MOAs
- ☐ Interface requirements specification documents
- ☐ DoDAF views of requirements and/or system architecture
- ☐ CRRA (Capabilities Review & Risk Assessment)

Reference Material: CONOPS IAW CJCSI 3170.01, **Analysis Handbook (OAS/DR)**, AFI 63-1201, AFI 10-601, AFI 10-602, CJCSI 6212.01, **AF Policy 1.2.1.3**, , DoDI 5000.02, AFI 33-103

Other Considerations: Requirements constraints may include technology and interface requirements, as well as non-technical constraints, e.g., policies, standards, legal, budget, and schedule constraints. Technology constraints include time-critical functions, timing dependencies, fault tolerance, redundancy, and graceful degradation. Human interface requirements should be consistent with human factors principles.

RG1P2 Establish and maintain concepts of operations and support that define the operational capability required

Description: Document the interaction of the product with the environment, other systems, and operational users. Obtain user concurrence on top level requirements and mission profiles. A conceptual set of mission profiles (i.e., use cases) fully describing the product boundaries, intended usage concepts, modes of operation and environments must be established, maintained, and validated by the appropriate subject matter experts (e.g., HSI community, intelligence community). Key capabilities should be described in specific scenarios with explicit measures of operational effectiveness and suitability.

Typical Work Products:

- ☐ Coordinated and Signed CONOPS (All Parties)
- ☐ Use cases
- ☐ Hierarchy of performance parameters (e.g., Key Performance Parameters (KPPs), Technical Performance Measures (TPMs))
- ☐ Performance Requirements Summary (Services)

Reference Material: CONOPS IAW CJCSI 3170.01, **Analysis Handbook (OAS/DR)**, AFI 63-1201, AFI 10-601, **AF Policy 1.2.1.3**, AFI 63-124

Other Considerations: Use cases/mission profiles should consider off-nominal potential operational concepts. . For services contracts (i.e., repair, overhaul), brainstorm with stakeholders of all dependent variables (what, when, where, who, quantity, quality levels, etc.) to ensure that all unique requirements have been considered. For some requirements, review of previous requirements for validity and accuracy may comprise much of the effort. Determine, prioritize, and activate sustainment actions to best address present and life-cycle system operational scenarios.

RG1P3 Transform stakeholder needs, expectations, constraints, and interfaces into a prioritized requirements baseline

Description: Transform stakeholder needs, expectations, constraints, and interfaces into a prioritized requirements baseline that will support requirements traceability and document related decisions to manage requirements evolution throughout development. Establish technical aspects of a solicitation package that include technical requirements of the acquisition and corresponding proposal evaluation criteria.

Typical Work Products:

- ☐ System Requirements Document/Performance Specification
- ☐ Performance Work Statement, for services
- ☐ ICD
- ☐ SOW, SOO
- ☐ Requirements list Performance Work Statement (for services contracts)

Reference Material: AFI 63-124

Other Considerations: Document requirements that have been identified through concept refinement or previous product development. Both hardware and software need to be considered in the specification of functional, performance, and interface requirements.

RG1P4 Establish and maintain a requirements/decision data archive to document requirements and related technical decisions

Description: Stakeholder needs, expectations, constraints, and interfaces are documented in a database of the end-item requirements and are used to manage overall performance expectations throughout the development, enable transfer to sustainment activities, and support requirements traceability.

Typical Work Products:

- ☐ Evidence of requirements database

Reference Material:

Other Considerations: Requirements management systems include tools such as CORE, DOORS, TeamCenter, etc.

RG2 Requirements are refined, elaborated, and allocated to support design or service(s)

RG2P1 Establish and maintain design mission reference profiles that define the product characteristics required in engineering terms and document the interaction of the product with the environment, other systems and operational users

Description: The conceptual set of mission profiles must be refined into a comprehensive set of design mission reference profiles that define the product performance boundaries, intended usage modes and environments in engineering terms. Key characteristics should be traceable to specific mission scenarios with derived measures of performance. The hierarchy of technical performance parameters should be extended to support detailed trade studies. Ensure user awareness of evolving product characteristics and changing mission scenarios.

Typical Work Products:

- ☐ Technical performance measurements (TPMs)
- ☐ Use cases/mission profiles

Reference Material:

Other Considerations: Consider anti-tamper requirements.

RG2P2 Allocate the requirements to each product-component

Description: Allocate requirements, in correlation with the top level architecture, to product segments or components. Iteratively decompose the high level requirement into lower level requirements. Define key interfaces and critical information exchange requirements in accordance with applicable standards, and where not directed, in accordance with accepted standards to the extent practical. Identify safety critical functions and ensure affected hardware and software components are treated as safety critical.

Typical Work Products:

- ☐ Specification/Drawing tree

- ☐ Software tree
- ☐ ICWG charter
- ☐ DoDAF views of functional architecture
- ☐ Functional Flow Block Diagrams
- ☐ Time Line Analysis
- ☐ Requirements Allocation Sheet
- ☐ ICDs (Interface Control Documents)
- ☐ ISP (Information Support Plan)
- ☐ IERs (Information Exchange Requirements)

Reference Material: AFI 63-124

Other Considerations: Key tools in a functional analysis and allocation are Functional Flow Block Diagrams, Time Line Analysis, and the Requirements Allocation Sheet.

RG3 Iteratively analyze and validate operational and derived requirements throughout the product life cycle

RG3P1 Analyze requirements to ensure that they are necessary and sufficient

Description: Concisely and completely describe the needed characteristics. Trace each requirement from a specific usage scenario. Ensure that the technical requirements accurately reflect the stakeholder's stated needs. Account for derived requirements that increase work scope (for example in software) as the development proceeds and the design understanding evolves. Establish and maintain a rationale for each requirement to improve the understanding and clarity of the need. Establish verification criteria and methods for each requirement. Evaluate incremental development and/or potential requirements evolution over time. Compare Technology Readiness Assessments to user requirements.

Typical Work Products:

- ☐ Technology Readiness Assessment (TRA) documents
- ☐ Verification matrix
- ☐ System Requirements Review (SRR) documents

Reference Material:

Other Considerations: If incremental development is used, control increment content by allocating all requirements up-front to specific increments.

RG3P2 Analyze requirements to balance stakeholder needs and constraints

Description: Establish and maintain the balance of stakeholder needs and project constraints, such as performance, usability, schedule, manufacturing, operational and supportability considerations, and life cycle cost. Perform trade studies using formal methods for decision analysis and analysis of alternatives. Document and obtain stakeholder coordination on key decisions affecting requirements.

Typical Work Products:

- ☐ Trade studies with AoAs

Reference Material:

Other Considerations: CAIV studies could be accomplished. Consider Technology Readiness. Consider an iterative process of requirements refinement involving the suppliers and the end user as the design matures. Ensure program baselines are consistent with estimates for the design effort (hardware and software), cost, and schedule, and the disciplined application of effective systems and software engineering processes.

RG3P3 Validate requirements to ensure the evolving product will perform as intended in the operational environment

Description: Requirements validation assures the technical requirements are the right requirements. The goal is to ensure that the product will be operationally safe, suitable and effective for its intended use in its intended environment. Requirements reflect immediate operational needs and the ability to support likely future needs. Use M&S to the maximum extent feasible. Ensure end user understanding and commitment to the evolving requirements.

Typical Work Products:

- ☐ Traceability matrix
- ☐ Successful SRR (signed action items & minutes)
- ☐ M&S results

Reference Material: AFI 63-124

Other Considerations: Consider the use of physical and computer based simulations accredited for the application by recognized authority.

RG4 Requirements are managed and controlled, and inconsistencies with technical plans and work products are identified

RG4P1 Use a disciplined process for accepting, vetting, approving, and providing requirements and changes to the suppliers

Description: Requirements changes from unauthorized sources that are outside the flow of the acquirer's established baseline management process are not allowed. Assess each change to a controlled requirement for impact to the project's performance, cost, and schedule baselines and to project risk. Change existing cost, schedule, and performance baselines to accommodate the requirements change. Minimize requirements creep. Vet new requirements through a standardized process. Develop verification methods as requirements are accepted into the baseline. Maintain bi-directional traceability between system and allocated requirements.

Typical Work Products:

- ☐ CM plan
- ☐ CCB process OI
- ☐ Requirements management plan

- ☐ Requirements allocation sheets
- ☐ Performance Plan

Reference Material: AFI 63-124

Other Considerations: Performance-based contracts should specify procedures or remedies for reductions in price (or fee) when services are not performed or do not meet contract requirements. Include software engineering representation on the requirements review board if applicable.

RG4P2 Establish and maintain commitment to the requirements

Description: Establish and maintain agreements with key stakeholders to manage expectations as the product characteristics evolve. Obtain requirements commitment from the stakeholders by having coordinated and approved documents that define requirements at multiple levels.

Typical Work Products:

- ☐ EMAs (Expectation Management Agreements)
- ☐ MOAs and MOUs
- ☐ Initial Capabilities Document (ICD)
- ☐ Product support management plan (?)
- ☐ Performance specifications
- ☐ Component specification

Reference Material:

Other Considerations: Stakeholders include other government agencies such as DCMA.

RG4P3 Establish and maintain bidirectional traceability between requirements and work products

Description: Bidirectional traceability ensures that all higher level requirements (and verification criteria) are accounted for by the totality of the lower level requirements. It also ensures that lower level requirements are tied to a parent requirement to prevent orphan requirements at the lower levels. Bidirectional traceability also supports requirements change impact analysis when either high or lower level requirements or verification criteria/methods require change.

Typical Work Products:

- ☐ Requirements traceability matrix
- ☐ Requirements tracking system
- ☐ Requirements correlation matrix/table

Reference Material:

Other Considerations:

RG4P4 Identify and resolve inconsistencies between requirements, project plans, and work products

Description: Make all technical plans, designs, and specifications consistent with and traceable to documented requirements.

Typical Work Products:

- ☐ Gap analysis
- ☐ Corrective action list

Reference Material:

Other Considerations:

8.7 Risk Management (RM)

The purpose of Risk Management is to identify potential problems before they occur, so that risk-handling activities may be planned and invoked as needed across the life of the product or project to handle adverse impacts on achieving objectives.

Risk identification and estimation of probability of occurrence and impact, particularly for those risks involved in meeting performance requirements, schedules, and cost targets, largely determine the acquisition strategy. The acquirer has a dual role: first, in assessing and managing technical risks for the duration of the project, and second, in assessing and managing technical risks associated with the performance of the supplier. As the acquisition progresses to the selection of a supplier, the risk specific to the supplier's technical and management approach then becomes important to the success of the acquisition.

The Risk Management process area can best be described by the following goals and practices.

Risk Management (RM)

RMG1 Prepare for Risk Management

RMG1P1 Determine risk sources and categories

Description: Establish categories of risks and risk sources for the project initially and refine the risk structure over time (e.g., schedule, cost, supplier execution, technology readiness, manufacturing readiness, product safety, and issues outside control of team), using Integrated Product Teams. Quantify the risk probability and consequence in terms of cost and schedule.

Typical Work Products:

- ☐ Risk matrix
- ☐ Risk management plan

Reference Material: DoD Risk Management Guide, AFI 90-901

Other Considerations: Consider using Acquisition Center of Excellence Risk Management Workshops when needed. For manufacturing risks consider the capability of planned production processes to meet anticipated design tolerances. Include the supplier's capacity and capabilities in the analysis.

RMG1P2 Define the parameters used to analyze and categorize risks, and the parameters used to control the risk management effort

Description: Record the parameters used to analyze and categorize risks so that they are available throughout the project period for reference when circumstances change over time.

Typical Work Products:

- ☐ Risk Management Plan

Reference Material:

Other Considerations: Recording the parameters used to analyze and categorize risks allows the risks to be easily re-categorized and analyzed relative to the original information when changes occur. Well defined parameters provide common and consistent criteria for analyzing, prioritizing and mitigating the risks to be managed.

RMG1P3 Establish and maintain the strategy and plans to be used for risk management

Description: Identify risks, roles, responsibilities, and relationships of stakeholders in the risk management process, schedule for addressing risks, and the plan to identify, assess, track, and handle (control/mitigate, avoid, assume or transfer) risks. Develop a Risk Management Plan (RMP) (may be developed jointly by the government, contractor, and suppliers). Update and use the RMP throughout the system's life cycle.

Typical Work Products:

- ☐ Risk Management Plan
- ☐ Systems Engineering Plan

Reference Material: Defense Acquisition University Risk Management Guide for DOD Acquisition, [AFMC Risk Pamphlet](#), DoD Risk Management Guide, MIL-STD-882, AFI 91-202, DoDI 5000.02, Directive Type Memorandum (DTM-08-048) SCRM to Improve the Integrity of Components Used in DoD Systems

Other Considerations: Consider performing periodic integrated risk assessments. Safety related risks are managed in accordance with AFI 91-202. Include in the overall risk strategy the Supply Chain Risk Management (SCRM) approach. SCRM includes both trusted key components and software or firmware that is free of malicious code. Define a process and criteria for escalating risks to the next higher management level. Establish a threshold for risk acceptance.

RMG2 Identify and analyze risks to determine their relative importance

RMG2P1 Identify and document the technical risks

Description: Document program, technology, and manufacturing risks in a concise statement that includes the sources, context, conditions and consequences of risk occurrence. The identification of issues, hazards, threats, and vulnerabilities that could negatively affect work efforts or plans is the basis for sound and successful risk management. Establish and maintain a failure mode and effects analysis to characterize how the product or manufacturing processes can fail.

Typical Work Products:

- ☐ Risk matrix
- ☐ FMECA
- ☐ Hazard Analysis

Reference Material: MIL-STD-1629A

Other Considerations: Risks must be identified and described before they can be analyzed and managed properly. Consider supportability risks in hardware, software and firmware. Pay particular attention to external factors which could influence a product acquisition and sustainment over which the team may have little control.

RMG2P2 Evaluate and categorize each identified risk using the defined risk categories and parameters, and determine its relative priority

Description: Assign relative importance to each identified risk, and use it to determine when appropriate management attention is required. Aggregate risks based on their interrelationships, and develop options for all risks within the category. Establish and maintain a criticality analysis to chart the probability of failure modes against the severity of their consequences.

Typical Work Products:

- ☐ Risk matrix
- ☐ FMECA
- ☐ Hazard Analysis

Reference Material: MIL-STD-1629A

Other Considerations: When an aggregate risk is formed by a roll up of lower level risks, care must be taken to ensure that important lower level risks are not ignored. The acquirer should assess project risks both independently and in conjunction with the supplier's risk management procedures.

RMG3 Perform risk handling to manage adverse impacts on the project

RMG3P1 Establish and maintain plans for mitigating each of the important risks to the project

Description: Develop an approach for handling each risk using the appropriate method and/or technology insertion. Risk handling methods include: avoidance; assumption; transfer; and control/mitigation. Evaluate risk handling plans for impact on all aspects of the project and ensure inclusion of risk mitigation plans in the Integrated Master Schedule. Document the plans, and coordinate with all stakeholders. Identify and assess alternative technologies for substitution in place of unacceptable higher risk technologies.

Typical Work Products:

- ☐ Risk transfer, assumption, avoidance, or mitigation plan
- ☐ Systems Engineering Plan
- ☐ Integrated Master Schedule

Reference Material:

Other Considerations: After identifying potential technology risks a project might develop an incremental approach for technology insertion later in the life cycle while using alternative lower risk technologies for the initial product units.

RMG3P2 Monitor and assess risk handling activities

Description: Continually monitor risks and risk handling, and, when warranted, adjust risk handling or mitigation plans. Establish a method to periodically review each risk and provide current status to stakeholders. Various risk handling paths may affect the project in ways difficult to foresee. Execute risk handling, including mitigation actions promptly.

Typical Work Products:

- ☐ Risk transfer, assumption, avoidance, or mitigation plan results

Reference Material:

Other Considerations:

8.8 Transition, Fielding, & Sustainment (TFS)

The purpose of the Transition, Fielding, & Sustainment process is to prepare for and execute the support, maintenance, repair, and disposal of a product while ensuring it is safe, suitable, and effective while it is fielded and operated.

Sustainment is the planning, programming, and executing of a support strategy. It includes specific activities in all phases of a product lifecycle from product concept formulation to demilitarization and disposal.

The Transition, Fielding, & Sustainment process area can best be described by the following goals and practices.

TFSG1 *Prepare to support operations, maintenance, repair, and disposal of the product.*

TFSG1P1 Establish and maintain plans for logistics support of the product.

Description: Establish and maintain initial and life-cycle resources requirements for performing operations and support. Establish and maintain mechanisms for ensuring the involvement of support organizations throughout product acquisition. Identify the policies which must be implemented to manage the failure modes which could cause the functional failure of the product in operations (e.g., reliability centered maintenance).

Typical Work Products:

- ☐ Integrated Logistics Support Plan
- ☐ Life Cycle Management Plan (LCMP)
- ☐ Item Unique Identification (IUID) Plan

- ☐ Depot Maintenance Activation Plan (DMAP) or Source of Repair Assignment Process (SORAP)
- ☐ Training plans
- ☐ Packaging, Handling, Storage and Transportation (PHS&T) documentation (see LHA reference)

Reference Material: AFI 63-101 , AFI 63-1201, DoDI 5000.02, AFI 63-1101, AFI 63-107, Logistics Health Assessment (LHA) Process Guide

Other Considerations: Plans should consider maintenance, manpower & personnel, supply support, support equipment, technical data, training & training support, computer resource support, facilities, packaging, handling, storage and transportation. Identify data rights and integrate with support strategy options (see LHA reference).

TFSG1P2 Establish and maintain the strategy and plan(s) for transitioning acquired products into operational use and support.

Description: Address objectives and scope of the transition, identification and responsibilities of the support organizations, resource requirements, criteria for transition from the development to the sustainment life cycle phase and related changes in authority and responsibility, definition of transition activities, schedule, installations of products to be delivered, warranty and data rights provisions

Typical Work Products:

- ☐ Transition support plan
- ☐ Depot Source of Repair (DSOR) package (Source of Repair Assignment, Depot Maintenance Inter-service, Strategic Source of Repair)
- ☐ Life Cycle Management Plan

Reference Material: AFI 63-101, Acquisition Sustainment Tool Kit

Other Considerations:

TFSG1P3 Establish and maintain plan(s) for the disposal of the product.

Description: Document disposal methodology of any existing products to be replaced as well as eventual disposal of the new product.

Typical Work Products:

- ☐ Disposal plan

Reference Material:

Other Considerations: Consider SMR (Source, Maintenance, Repair) codes and DRMO (Defense Revitalization & Marketing Office).

TFSG2 Ensure the resources, capacity and capability to support the operations, maintenance, repair, and disposal of the product are ready prior to need.

TFSG2P1 Establish and maintain budgets for sustainment activities.

Description: Ensure that sustainment organizations have established funding (e.g. amounts and sources) that complement ongoing acquisition funding and are consistent with suppliers' warranties, product deliveries and plans for supporting the product.

Typical Work Products:

- ☐ POM input

Reference Material: AFI 21-101, AFI 38-201

Other Considerations:

TFSG2P2 Establish and maintain processes and procedures for repair, overhaul, or modification.

Description: Ensure product technical documentation for repair, overhaul, or modification and associated training for support personnel is complete and verified.

Typical Work Products:

- ☐ Technical orders/manuals (see LHA reference)
- ☐ Work process orders
- ☐ Drawings
- ☐ Procedures/process flow charts
- ☐ Work Control Documents (WCD)

Reference Material: AFPD 23-1, T.O. 00-5-1, AFI 21-303, AFI 21-101, Logistics Health Assessment (LHA) Process Guide

Other Considerations: This documentation complements the technical data developed during design and manufacturing. Address qualification and approval of special processes up front and early. All process documentation affecting product quality should be placed under configuration control.

TFSG2P3 Ensure readiness for fielding and transition to operations and support.

Description: Identify and monitor contract requirements for support products and services. Conduct Provisioning Conferences and perform associated planning to support sustainment. Identify and monitor requirements for initial spares, support equipment, facilities and facility modifications. Establish and maintain criteria and agreements for transition to operations and support. Ensure qualified suppliers continue to exist for parts and materials.

Typical Work Products:

- ☐ Contract
- ☐ Spares list

- ☐ Sustainment planning
- ☐ DMSMS plan
- ☐ Packaging Handling, Storage, & Transportation (PHS&T) documentation (PHS&T available in support of provisioning plan)

Reference Material: AFI 21-101, SD22

Other Considerations: Stakeholders should participate in Provisioning Conferences and associated planning to ensure appropriate sustainment support will be available and timely.

TFSG2P4 Ensure product support is maintained during transition.

Description: Activate the product in its intended operational situation and monitor product operations to ensure stakeholder satisfaction. Analyze the results of all transition activities and identify appropriate action.

Typical Work Products:

- ☐ Fielded performance data
- ☐ PHS&T documentation (see LHA reference)

Reference Material: Logistics Health Assessment (LHA) Process Guide

Other Considerations: Fielded system performance data can be obtained from maintenance systems such as REMIS, CAMS, DRILS etc. and maintenance reports, accident investigation reports, and supplier databases. Execute Packaging, Handling, Storage, and Transportation (PHS&T) if appropriate.

TFSG2P5 Establish and maintain the required facilities, manpower, tooling and test equipment for repair, overhaul, or modification

Description: Define requirements for support equipment, facilities and facility modifications. Identify required manpower (quantity and type) and personnel qualifications (education, training, skills and experience).

Typical Work Products:

- ☐ Facilities plan
- ☐ Staffing plan
- ☐ Test equipment/tooling list
- ☐ Training material
- ☐ Life Cycle Sustainment Plan (LCSP)

Reference Material: AFI 63-101, AFI 21-101, AFI 36-2232

Other Considerations: Infrastructure considerations include buildings, workspace, associated utilities, tooling, capital equipment, and supporting services such as transport, communication or special handling.

TFSG3 *Repair, overhaul, or modify the product*

TFSG3P1 Repair, overhaul or modify the product in accordance with established procedures and processes.

Description: Ensure that repair, overhaul or modification operations are carried out in accordance with approved technical data. Establish monitoring, measurement, analysis, and improvement processes to ensure conformity of the product, with feedback mechanisms for continued quality.

Typical Work Products:

- ☐ List of tools, special inspection equipment, test equipment etc. and instructions associated with their use
- ☐ Critical process procedures
- ☐ Test plans/procedures
- ☐ Drawings
- ☐ Parts Lists
- ☐ Process documents
- ☐ Inspection documents

Reference Material: AFI 63-501, AFI 63-1101, T.O. 00-5-1

Other Considerations: The use of statistical process control is appropriate for high-volume processing. Incorporate Reliability Centered Maintenance (RCM) concepts to determine level and type of maintenance needed. Establish a preventative maintenance program based on the principles of RCM which is the optimum mix of reactive, proactive, time or interval-based, and condition based maintenance practices to maximize system reliability while minimizing life-cycle costs. In implementing a particular type of maintenance practice, consider the probability and consequence of failure, available historical data, risk tolerance and resource availability.

TFSG3P2 Establish and maintain inventory and supplier management/control to execute the repair, overhaul or modification

Description: Develop procedures and guidelines for evaluating and selecting qualified manufacturers. Establish feedback mechanisms to ensure continued quality, including review of product documentation, periodic inspections and audits at supplier's premises, and measurement systems. Establish agreements with the supplier for notification and if necessary, acquirer approval of nonconforming product/material and right of access by acquirer to all applicable data and records related to purchased products/materials. Identify and negotiate repair and overhaul rates.

Typical Work Products:

- ☐ Qualified supplier list
- ☐ Certificate of conformity
- ☐ Supplier rating
- ☐ Contract

Reference Material: Federal Acquisition Regulation (FAR), AFI 63-501

Other Considerations:

TFSG4 *Maintain Operational Safety, Suitability, and Effectiveness (OSS&E)*

TFSG4P1 Establish and maintain OSS&E baseline(s).

Description: Establish, maintain and document OSS&E baseline(s) in an OSS&E Baseline Document (OBD) during operational use with stakeholder coordination. Develop mechanisms to ensure conformity to the OBD (i.e., health monitoring and testing of fielded products carried out with results documented and compared to the appropriate baseline measures). Take action to analyze and correct deficiencies, If results do not compare favorably. Maintain all required certifications. Document procedures for coordination of OSS&E assurance among related products.

Typical Work Products:

- ☐ Surveillance test plan
- ☐ Weapon Systems Evaluation Program
- ☐ OBD

Reference Material: AFI 63-1201, AFI 63-101, TO 00-35D-54 – Joint Deficiency Reporting System (JDRS)

Other Considerations:

TFSG4P2 Identify and monitor safety critical items

Description: Establish and maintain a disciplined process for handling of safety critical items, including identification of established technical authorities, quality assurance, and qualified manufacturers.

Typical Work Products:

- ☐ Safety Critical Items and/or Critical Safety Items list

Reference Material: **AFMAN 23-110, Aviation Critical Safety Item Management Handbook, AFI 63-1201**, MIL-STD-882 (DoD Standard Practice for System Safety), AFI 20-106 (Management of Aviation Critical Safety Items)

Other Considerations:

TFSG4P3 Identify and mitigate hazards

Description: Establish and maintain a hazards tracking database. Ensure high/serious hazards are mitigated or accepted by appropriate authority. Establish and maintain a process for handling accidents involving the product.

Typical Work Products:

- ☐ Hazards list
- ☐ Mishap

☐ Hazard Analysis

Reference Material: AFMCPAM 91-104, AFI 63-1201

Other Considerations:

TFSG4P4 Identify and monitor operations and maintenance data

Description: Establish mechanisms for collecting, reviewing and acting upon data related to product operations and support (e.g. defects, flight hours, anomalies). Monitor reliability, maintainability, supportability data, as well as that for the other Integrated Logistics Support (ILS) areas.

Typical Work Products:

☐ Databases

Reference Material: AFI 63-501, AFI 21-101, TO 00-35D-54 – Joint Deficiency Reporting System (JDRS)

Other Considerations: Maintain awareness of system performance against stakeholder collaborated availability requirements. One approach is to consider usage of Core Automated Maintenance System (CAMS).

TFSG4P5 Execute (as required) the plan for decommissioning and disposal of the product

Description: Identify and monitor requirements for system disposal or migration to long term storage.

Typical Work Products:

☐ Disposal plan

Reference Material: AFI 16-402, AFI 63-101

Other Considerations: This only applies to programs that have actually disposed products, components, etc.

8.9 Technical Management & Control (TMC)

The purpose of Technical Management and Control (TMC) is to provide an understanding of the project's technical progress so that appropriate corrective actions can be taken when the project's performance deviates significantly from the plan. TMC provides for establishing and managing the project and the involvement of relevant stakeholders following the principles of Integrated Product and Process Development (IPPD). It also allows for developing and sustaining the infrastructure and measurement capability to support management information needs.

A project's documented plan is the basis for monitoring activities, communicating status, and taking corrective action. Progress is primarily determined by comparing actual work product and task attributes, effort, cost, and schedule to the plan at prescribed milestones or control levels in the project schedule or WBS. Appropriate visibility of progress enables timely corrective action to be taken when performance deviates significantly from the

plan. A deviation is significant if, when left unresolved, it precludes the project from meeting its objectives.

The term *project plan* is used throughout these practices to refer to the overall plan for controlling the project.

Monitoring and control functions are established early in the project as the project's planning is performed and the acquisition strategy is defined. As the acquisition of technology solutions unfolds, monitoring and control activities are essential to ensure that appropriate resources are being applied and that acquirer activities are progressing according to plan.

When actual status deviates significantly from expected values, corrective actions are taken, as appropriate. These actions may require replanning, which may include revising the original plan, establishing new agreements, or including additional mitigation activities in the current plan.

If corrective action is required to resolve variances from project plans, these actions should be defined and tracked to closure.

The Technical Management & Control process area can best be described by the following goals and practices.

TMCG1 Prepare for Integrated Management

TMCG1P1 Establish and maintain the project environment.

Description: Define the project's processes to form an integrated approach for managing the product throughout its lifecycle. Implement technical standard work and process guidelines. Establish a work environment which facilitates work by co-located or distributed teams.

Typical Work Products:

- ☐ Standard Operating Procedures (OIs, guides. etc.)

Reference Material: DoDI 5000.02

Other Considerations: Consider common collaborative tools for communication and development (e.g. DOORS, Net Meeting, MS Project, Live Link, integrated development environment (IDE), Communities of Practice (CoP) etc.)

TMCG1P2 Establish and maintain supplier agreements.

Description: Evaluate and recommend optimal acquisition type (e.g., COTS, Formal Agreement, In-House Vendor, etc) for each product or product component to be acquired. Establish technical requirements and provide support to contracting agency to select suppliers and establish supplier agreements (e.g., SOW, Contract, MOA).

Typical Work Products:

- ☐ Acquisition strategy
- ☐ Instructions to offerors
- ☐ Technical evaluation areas, factors and criteria
- ☐ Supplier agreements or subcontracts
- ☐ Statement of Objectives (SOO)
- ☐ Program Statement of Work
- ☐ List of compliance standards and specifications
- ☐ Contract Data Requirements List (CDRL)
- ☐ Request for Proposal Package

Reference Material:

DoD Guide for Contracting for SE, [Defense Acquisition Guide](#)

Other Considerations: Ensure supplier agreements provide the project team insight into key supplier/subcontractor selection and their processes/activities. Include suppliers (below prime contractor level) in the IPPD construct. Any supplier processes that are critical to the success of the project should be identified in the supplier agreement and monitored during execution. In cases of low risk it is possible that no processes are formally monitored. For software-intensive systems, identify software as a separate sub-factor for supplier evaluation. Ensure that the supplier commits to their Software Development Plan (SDP) as the controlling plan for software processes. Ensure that planned software development effort and schedule is consistent with the overall program budget and development schedule.

TMCG1P3 Establish and maintain integrated product teams (IPT).

Description: Establish a shared vision for the project consistent with the mission, goals, expectations, and constraints with stakeholder participation. Establish and maintain integrated teams based on a product oriented hierarchy. Allocate requirements, responsibilities, tasks and interfaces to teams in the integrated team structure. Document the team membership, its leaders, resources and other constraints.

Typical Work Products:

- ☐ IPT Charter
- ☐ IPT minutes

Reference Material: DoD IPPD document

Other Considerations: Considerations should include stakeholder turnover and periodic team health checks to verify if team members are fulfilling their established and agreed-upon roles and responsibilities.

TMCG1P4 Establish and maintain measurement approach

Description: Establish measurement objectives and measurement criteria based on projects risks and issues. Specify how measurement data will be obtained, stored, updated and presented. Specify measures and analysis procedures to address information needs. Determine the frequency of data measurement by consideration of project maturity/complexity and stakeholder needs.

Typical Work Products:

- ☐ Measurement Objectives
- ☐ TPMs
- ☐ EVM
- ☐ Software measurements

Reference Material: Air Force Weapon Systems Software Management Guidebook

Other Considerations: Appropriate information must be identified in order to develop and sustain the measurement capability that is used to support management information and decision-making needs. Attention to storage and retrieval procedures helps ensure that data are available and accessible for future use. Air Force core software metrics (size, effort, schedule, quality, requirements definition and stability, staffing, progress, and computer resources utilization) should be used to track all software to be developed, integrated, and delivered. Core metrics should be supplemented with additional software metrics as appropriate, including emphasis on complexity of the software to be developed, staff capability and productivity rather than simply quantity, etc. Measurement and analysis applies to tracking the progress of the acquisition team as well as the progress of the supplier.

TMCG2 Perform Integrated Management.

TMCG2P1 Monitor and control the project in accordance with project commitments.

Description: Monitor and control performance of agreements on commitments addressing each critical dependency with those responsible for providing or receiving the work product

Typical Work Products:

- ☐ Review report
- ☐ List of critical dependencies
- ☐ Status of critical dependencies
- ☐ MOAs
- ☐ GFP list
- ☐ Interface list

Reference Material:

Other Considerations: Deliverables from an external project (e.g. government furnished property) necessary to comply with program schedule. Outgoing: project deliverables (e.g. equipment or data) to other projects that depend upon those deliverables to meet their schedules. Think: System of Systems and Service Oriented Architecture (SOA) services.

TMCG2P2 Monitor & control coordination and collaboration.

Description: Manage stakeholder involvement. Resolve coordination issues. Ensure collaboration among interfacing teams. Monitor Stakeholder involvement.

Typical Work Products:

- ☐ MOAs,
- ☐ Minutes

Reference Material:

Other Considerations:

TMCG2P3 Execute Supplier Agreements.

Description: Monitor and accomplish technical activities as specified in supplier agreements. Monitor selected supplier processes. Evaluate and accept the supplier products.

Typical Work Products:

- ☐ Status Reports
- ☐ Design review slides and minutes
- ☐ Process review and discrepancy reports
- ☐ Receiving reports

Reference Material:

Other Considerations: Perform technical activities with supplier(s) as described in the agreement(s). This typically includes periodic and event driven technical interchange meetings, and periodic status reports. Any processes that were identified for monitoring should be analyzed to proactively identify serious issues. Acceptance reviews, tests, and configuration audits should be accomplished before accepting the product as defined in the supplier agreement(s). Assess how well the supplier is adhering to their documented development and sustainment processes and evaluate the effectiveness of their defined processes. The assessments may be conducted as informal reviews or independent assessments.

TMCG2P4 Obtain and analyze specified measurement data.

Description: Collect and analyze measurement data as planned, conduct additional analysis as necessary, review results with relevant stakeholders, and refine measurement criteria for future analysis. Monitor and analyze progress against technical, cost, and schedule plans immediately after they are established and throughout the life cycle. Analyze root causes of variances.

Typical Work Products:

- ☐ EVMS reports
- ☐ Variance analysis reports
- ☐ Software metrics reports

Reference Material: Department of Defense. Practical Software and Systems Measurement Guidebook. www.psmc.com, ANSI/EIA-748, Defense Acquisition Guidebook Chapter 11, and the DoD Earned Value Management Implementation Guide (Oct 06)

Other Considerations:

TMCG2P5 Monitor the development and delivery of project data.

Description: Review deliverable technical data for completeness, accuracy, and currency to ensure program integrity and health. Review the process for developing the project data.

Typical Work Products:

- ☐ Records of data management reviews
- ☐ Records of supplier data management
- ☐ Drawing release process

Reference Material:

Other Considerations:

TMCG3 Monitor & control technical progress

TMCG3P1 Technical reviews and audits are conducted when all the key entry criteria are met and closed when the exit criteria are met.

Description: Plan and conduct technical reviews, assessments, and audits in accordance with the IMP/IMS using the applicable standards and regulations.

Typical Work Products:

- ☐ Review minutes
- ☐ Action items
- ☐ Records

Reference Material: Defense Acquisition Guide

Other Considerations: Projects can utilize independent review teams as warranted.

TMCG3P2 Assess results of technical reviews to support key milestone decisions, higher level reporting, and project re-planning as required

Description: Self-explanatory

Typical Work Products:

- ☐ PoPS
- ☐ SMART

- ☐ DAES
- ☐ SARS
- ☐ Milestone decision review minutes
- ☐ PMR documentation
- ☐ Progress review minutes

Reference Material:

Other Considerations: Results of technical reviews may drive a change in project direction.

TMCG3P3 Manage project work products and data

Description: Manage project data, work products and documents with the appropriate levels of version control. Monitor the established mechanisms to ensure project data are controlled.

Typical Work Products:

- ☐ SEP approval procedures
- ☐ IDE version control policy
- ☐ Contract change process
- ☐ Integrated baseline review
- ☐ LCMP approval procedures

Reference Material:

Other Considerations:

TMCG4 Monitor and Control Corrective Actions

TMCG4P1 Collect and analyze the project issues to determine and track corrective actions

Description: Collect and analyze project issues through program management reviews, technical reviews, milestone reviews, and analysis of program metrics. Perform corrective actions as required by modifying the product; statement of work/objectives; modifying requirements/specifications; revising estimates and plans; renegotiating commitments; adding resources; changing processes; or revising mitigation actions.

Typical Work Products:

- ☐ Engineering change proposals
- ☐ Contract change proposals
- ☐ Trade Studies

Reference Material:

Other Considerations: Corrective action should be determined in sufficient time to properly resolve the issue.

TMCG4P2 Establish and maintain a deficiency reporting system

Description: A deficiency reporting information system is established and maintained that includes deficiency identification, root cause analysis, and corrective action mechanisms. Establish and maintain criteria, processes, and procedures for determination and disposition of nonconforming products to prevent their unintended use or delivery.

Typical Work Products:

- ☐ Deficiency Reports
- ☐ Deficiency reporting system
- ☐ Corrective Action reports

Reference Material: T.O. 00-35D-54, AFI 21-104, AFI 21-118, AFI 63-501, AFI 63-1201

Other Considerations: An automated defect reporting/tracking system can enhance timely analysis of problem areas and verification of effectiveness of action taken to correct problems. A corrective action team should be established to ensure adequate attention to the causes of defects.

TMCG4P3 Manage corrective actions to closure.

Description: Monitor and manage corrective actions to closure, identifying and collecting lessons learned to be used to update processes.

Typical Work Products:

- ☐

Reference Material:

Other Considerations: Management to closure includes analyzing results of corrective actions to determine their effectiveness; determining and documenting appropriate actions to correct deviations; and documenting lessons learned to support future planning and risk management activity.

8.10 Verification and Validation (V)

The purpose of Verification is to ensure that work products meet their specified requirements. The purpose of Validation is to demonstrate that a product or product component fulfills its intended use when placed in its intended environment.

Verification and validation methods (e.g., peer reviews, modeling and simulation) can be applied to work products (e.g., designs and prototypes) as well as to the product and product components. The work products should be selected based on which are the best

predictors of how well the delivered end product and product components will satisfy user needs.

The acquirer should ensure that a proper verification environment exists, that it selects work products to evaluate based on documented criteria, and that the supplier uses appropriate methods to verify its work products. In this context, the test and evaluation community is a major stakeholder, and should participate in up-front planning through final-product acceptance.

The supplier and/or the test community may perform many of these practices, with the acquirer facilitating the correction of deficiencies or enhancements by the supplier or follow-on maintenance organization. It is important that the acquirer define at the outset the degree to which verification and validation are required both early in the definition of the project and later when the products are received. Test and analysis techniques should be implemented as early as possible to identify deficiencies that require corrective action to meet system requirements.

Product verification activities are routinely conducted throughout the entire contract performance period, and results are analyzed to determine acceptability of the products. Validation activities are normally performed early and continuously throughout the acquisition life cycle. Product validation activities can be applied to all aspects of the product in any of its intended environments, such as operation, training, manufacturing, maintenance, and support services.

The Verification and Validation process area can best be described by the following goals and practices.

VG1 Prepare for verification

VG1P1 Establish and maintain the overall verification strategy and plan, including integrated testing approach

Description: Address, in the verification strategy, the technical approach to product verification and the specific approaches that will be used to verify that work products meet their specified requirements. Establish verification criteria and methods for each requirement. Proactively seek opportunities for combined testing with the operational test agencies and oversight offices and form an Integrated Test Team.

Typical Work Products:

- ☐ Document modeling, simulation, ground and flight test activities planned for product verification in the Test and Evaluation Master Plan (TEMP) or similar document if a TEMP does not exist.
- ☐ Use Cases are used to define test requirements.
- ☐ Early test strategy, Test and Evaluation Strategy

Reference Material: AFI 99-103, AFI 16-1001, AFI 16-1002, Defense Acquisition Guide (DAG) Chapter 9

Other Considerations: Work products can be developed by either the acquirer or suppliers. They should be selected based on their contribution to meeting project objectives and requirements, and to addressing project risks.

VG1P2 Identify the work products to be verified and the verification methods that will be used

Description: Identify work products requiring verification and any associated constraints. Develop, coordinate and document verification methods. Develop verification methods concurrently and iteratively with the product and product-component requirements and designs.

Typical Work Products:

- ☐ TEMP
- ☐ Verification Methods Table (e.g. Requirements Specification Section 4)

Reference Material: Defense Acquisition Guide (DAG) Chapter 9 and AFI 99-103 – Capabilities-Based Test & Evaluation

Other Considerations: Work products are developed by either the acquirer or suppliers. Assure verification methods address the technical approach to work product verification and the specific approaches that will be used to verify that work products meet their specified requirements.

VG1P3 Establish and maintain the environment and resources needed to support verification

Description: Identify facilities and support required. Ensure that impacts to external environment (e.g. emission of various pollutants and noise into the environment, electromagnetic radiation, etc) are within allowable NEPA limits. Obtain required certifications.

Typical Work Products:

- ☐ TEMP
- ☐ PESHE
- ☐ Certifications (e.g., safety, hazard classification, insensitive munitions qualification, SEEK EAGLE, security, airworthiness, flightworthiness, frequency authorizations, information assurance)
- ☐ Statement of Capability (SOC) (Agreement between program office & test organization)

Reference Material:

Other Considerations: Resources include labs, assembly areas, operators, tools, automation, training, maintenance infrastructure, test ranges and simulation environments.

VG1P4 Establish verification procedures and criteria

Description: Develop, coordinate and document verification criteria and procedures.

Typical Work Products:

- ☐ Work product test plan/procedures

Reference Material:

Other Considerations:

VG2 *Peer reviews are performed*

VG2P1 Prepare for peer reviews of selected work products

Description: Ensure peer reviews are planned on selected work products to find and remove defects in order to comply with established standards. Identify data to be collected and entry and exit criteria. Establish a process to track findings through disposition.

Typical Work Products:

- ☐ Solicitation documents (ex: SOW)
- ☐ System engineering plans
- ☐ Peer review entry and exit criteria
- ☐ Peer review process plan
- ☐ Software Development Plans

Reference Material:

Other Considerations: Planning activities should include identification of key reviewers, scheduling, preparing and updating materials such as checklists and review criteria, and selection of work products for review. A peer review is a method for conducting verification of work products during their development that has had great success in detecting defects, especially in documents for requirements and design. The intent is for the project to use peer reviews on selected products to find and remove defects and to ensure compliance to applicable standards. The suppliers typically use peer reviews internally on selected interim work products during development, but the acquirer should not rely solely on these results. Peer reviews within a project should include "independent" participants from other organizations not directly connected to the material being reviewed.

VG2P2 Conduct peer reviews on selected work products and identify issues resulting from the peer review

Description: Record and retain results of peer reviews, including defects, issues, and action items. Assign action items and communicate issues to stakeholders.

Typical Work Products:

- ☐ Findings
- ☐ Action items

Reference Material:

Other Considerations:

VG3 *Work products are verified*

VG3P1 Perform verification on the selected work products

Description: Verify work products, using approved methods and procedures, to promote early detection of problems, timely removal of defects, and reduce cost. Conduct Functional Configuration Audits (FCA) to verify the actual performance meets specification requirements. Verify that interfaces conform to established standards, agreements and specifications, and lower level designs are consistent with top-level designs. Implement pedigree checks and/or test item configuration auditing for important test events.

Typical Work Products:

- ☐ FCA results
- ☐ Findings
- ☐ Action items
- ☐ Test report

Reference Material:

Other Considerations:

VG3P2 Analyze and document the results of all verification activities

Description: Document and manage the results of verification as an element of the project data management effort. Conduct analysis to identify trends, process improvement opportunities and potential risks.

Typical Work Products:

- ☐ Test reports

Reference Material:

Other Considerations:

VG3P3 Initiate and document corrective actions

Description: Track corrective actions until subsequent verification activities confirm compliance with requirements.

Typical Work Products:

- ☐ Action item list
- ☐ Test report

Reference Material:

Other Considerations: Data on verification and corrective actions should be available to the acquirer and suppliers organizations as well as to other appropriate stakeholders.

VG4 *Prepare for validation*

VG4P1 Develop a product validation strategy and identify work products for validation.

Description: Ensure the validation strategy addresses the technical approach to demonstrate that user needs are satisfied. Select work products for validation against the users' needs and to address product performance risks.

Typical Work Products:

- ☐ Product validation strategy (briefing charts, outline, etc)

Reference Material:

Other Considerations: It is important that the team define at the outset the degree to which validation is required both early in the project (e.g., requirements validation activities) and later when the end products are available. All planned modeling, simulation, ground and flight test activities to validate performance, safety, suitability, survivability, and effectiveness in the intended operational environment is documented.

VG4P2 Establish and maintain validation criteria, methods and procedures.

Description: Develop, coordinate and document validation criteria, methods and procedures. Define validation procedures and criteria to ensure that the product will fulfill its intended use when placed in its intended environment. Develop and document procedures and criteria to support military utility assessments by the operational test activity.

Typical Work Products:

- ☐ Detailed test plans/procedures

Reference Material:

Other Considerations: It is important that the acquirer define at the outset the degree to which validation is required both early in the project (e.g., requirements validation activities) and later when the end products are received.

VG4P3 Establish and maintain the environment and resources needed to support validation

Description: Ensure that an adequate environment to carry out validation activities is maintained. Ensure that operators, enabling systems, and test facilities will be available in order to conduct validation.

Typical Work Products:

- ☐ Agreement with the test activity (e.g. Statement of capabilities (SOC))
- ☐ TEMP

Reference Material:

Other Considerations: The validation environment should be precisely controlled to provide for replication, analysis of results, and revalidation of problem areas.

VG4P4 Ensure appropriate certifications & accreditations have been completed

Description: Plan for and obtain certifications required for validation activities before relevant need date.

Typical Work Products:

- ☐ Certifications (e.g., safety, hazard classification, insensitive munitions qualification, SEEK EAGLE, security, airworthiness, flightworthiness, frequency authorizations, information assurance)
- ☐ Project Mgt Plan
- ☐ SEP

Reference Material: AFMAN 63-119

Other Considerations: Certification of readiness to test before entering a formal product validation phase should be accomplished by the project manager.

VG4P5 Establish and maintain a documented plan for validation

Description: Document all modeling, simulation, ground and flight test activities planned for product validation.

Typical Work Products:

- ☐ TEMP
- ☐ Modeling and simulation plan

Reference Material:

Other Considerations: Proactively seek opportunities for combined testing with the operational test agencies and oversight offices.

VG5 Validate product to ensure that it will be safe, suitable and effective in the intended operating environment

VG5P1 Perform validation on the selected products and product-components

Description: Perform validation activities and collect resulting data according to the approved methods, procedures, and criteria.

Typical Work Products:

- ☐ Test Data
- ☐ Detailed test plan
- ☐ Test procedures

Reference Material:

Other Considerations: Product interoperates with the enabling systems that will be present in the operational environment

VG5P2 Analyze and document the results of the validation activities

Description: Document and manage results of validation as an element of the project data management effort. Conduct analysis to identify trends and process improvement opportunities. Identify issues and initiate and document corrective actions. Track corrective actions to closure by an established and documented process and communicate to appropriate stakeholders.

Typical Work Products:

- ☐ Test Reports
- ☐ Validation issues
- ☐ Validation deficiency reports
- ☐ Procedure change requests

Reference Material:

Other Considerations:

9. Generic Practices

Generic practices are practices that must be accomplished for each process area. Within the AF SEAM, goals were created within each process area for application of both the generic practices and the specific practices that appear in each process area description. Generic practices improve the power of a process by ensuring that the specific practices are executed and that there is appropriate planning of the process to ensure that it is feasible and well supported and that stakeholders are properly involved.

9.1 GP1 Establish and maintain the description of a process

Description: Establish and maintain a documented description of the process.

Typical Work Products:

- ☐ Operational instructions (OIs)
- ☐ Process descriptions

Reference Material:

Other Considerations: The documented process provides the basis for planning, performing, and managing the activities, work products, and services associated with the process. The process description may reference or tailor higher level processes.

9.2 GP2 Establish and maintain plans for performing the process

Description: Establish and maintain a plan to implement the activities necessary to perform the process. As a minimum, a plan describes: activities, resources, and schedule required to accomplish the process.

Typical Work Products:

- ☐ Process execution plans as applicable to the process area (Ex: SEP, LCMP, ILSP, CMP, and associated internal working documents)

Reference Material:

Other Considerations: Objectives may be derived from other plans (e.g., the project plans) and should include objectives for the specific situation, such as quality, cost, and schedule objectives. Schedules may be event driven. The plan for performing the process should typically include the following elements:

- process description
- standards for the work products and services of the process
- requirements for the work products and services of the process
- specific objectives for the performance of the process (e.g., quality, time scale, cycle time, and resource usage)
- dependencies among the activities, work products, and services of the process
- resources (including funding, people, and tools) needed to perform the process
- assignment of responsibility and authority
- training needed for performing and supporting the process, including proficiency and project team training
- work products to be placed under configuration management and the level of configuration management for each item
- measurement requirements to provide insight into the performance of the process, its work products, and its services
- involvement of identified stakeholders
- activities for monitoring and controlling the process
- objective evaluation activities for the process and the work products
- management review activities for the process and the work products

Establishing a plan includes documenting the plan and providing a description of the process it implements. Maintaining the plan includes changing it as necessary in response to either corrective actions or to changes in requirements and objectives for the process.

9.3 GP3 Provide adequate resources for performing the process, developing the work products, and providing the services of the process

Description: Ensure that the resources necessary to perform the process are available when they are needed. Resources include adequate funding, appropriate physical facilities, skilled people, and appropriate tools.

Typical Work Products:

- ☐ Staffing plan (names and skill sets)
- ☐ Funding profile
- ☐ Resource availability schedule
- ☐ Tools list

Reference Material:

Other Considerations:

9.4 GP4 Assign responsibility and authority for performing the process, developing the work products, and providing the services of the process

Description: Ensure that there is accountability for performing the process and achieving the specified results throughout the life of the process. Assign responsibility using detailed job descriptions or project documents. Ensure personnel designated have the documented authority to perform the assigned responsibilities.

Typical Work Products:

- ☐ Roles and responsibility descriptions
- ☐ Charters
- ☐ Delegation of authority letters/memo

Reference Material:

Other Considerations:

9.5 GP5 Train the people performing or supporting the process as needed.

Description: Ensure that proficiency and process training for the entire project team including stakeholders is performed and documented. Overview training is provided to orient people who interact with those performing the work. Allow the people to take the required training.

Typical Work Products:

- ☐ Training materials
- ☐ Training records
- ☐ Training schedules

Reference Material:

Other Considerations Examples of methods for providing training include self-study; self-directed training; self-paced, programmed instruction; formalized on-the-job training; mentoring; and formal and classroom training.

9.6 GP6 Monitor and control the process

Description: (1) Ensure that the process is performed as planned. (2) Objectively ensure that the process adheres to its process description. (3) Objectively evaluate work products against the applicable standards and ensure the process yields the desired outcomes/products. (4) Identify issues and take corrective action as necessary.

Typical Work Products:

- ☐ Process review reports
- ☐ Metrics
- ☐ Deficiency reports
- ☐ Corrective action plans

Reference Material:

Other Considerations: This typically involves: (A) Measuring attributes of the process and work products produced by the process; (B) Provide metrics showing trends to support proactive improvements; (C) Developing corrective actions and track to closure; and (D) Providing feedback to process stakeholders. Additionally, independent assessments and feedback are an effective means of ensuring compliance and continuous process improvement. NOTES: 1. Under item “(2)” above the word “objectively” refers to an examination of the process which may be performed by peers or as an integral part of the process. 2. Under item “(3)” above the word “objectively” refers to ensuring that the process meets customer needs and may involve direct customer feedback.

9.7 GP7 Review the activities, status, and results of the process with higher level management and resolve issues

Description: Provide higher level management with visibility into the results of execution of the process. Perform process reviews to provide recommendations for policy, process, and resources to facilitate improvement.

Typical Work Products:

- ☐ Briefings
- ☐ Meeting minutes
- ☐ Recommendations

Reference Material:

Other Considerations:

10. Point of Contact

AF SEAM is designed as a Continuous Process Improvement (CPI) tool. Accordingly, the model itself must undergo CPI in order to remain current and relevant. Please submit recommended improvements or comments to your center's AF SEAM POC.